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R. P. Rothwell, C. E.
with compliments of
J. M. Hodge

Kentucky. Geological survey.

GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

PRELIMINARY REPORTS

ON THE

SOUTH-EASTERN KENTUCKY COAL FIELD.

BY

A. R. CRANDALL AND ~~G.~~J. M. HODGE,
ASSISTANTS.

1887.

STEREOTYPED FOR THE SURVEY BY JOHN D. WOODS, PUBLIC PRINTER AND BINDER, FRANKFORT, KY.

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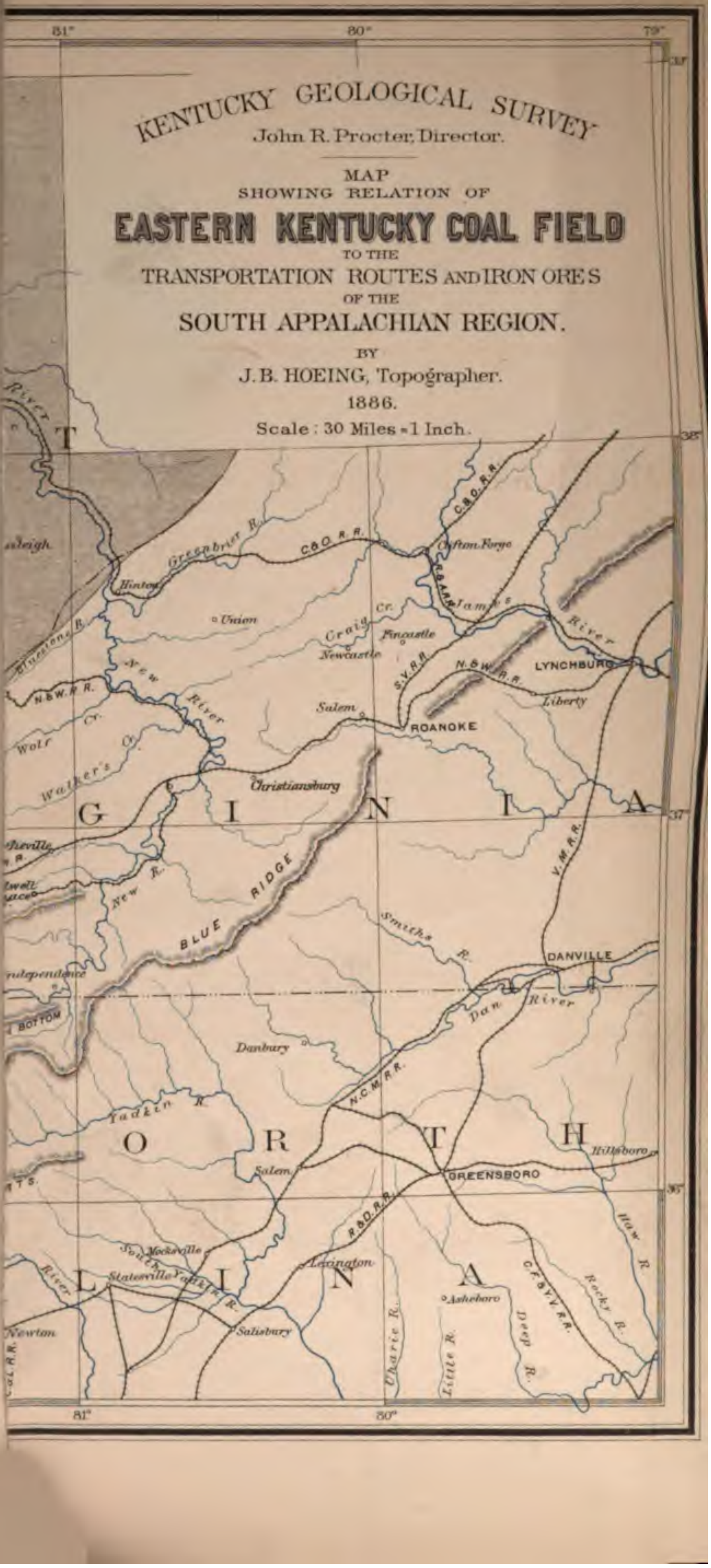

KENTUCKY GEOLOGICAL SURVEY
John R. Procter, Director.

MAP
SHOWING RELATION OF
EASTERN KENTUCKY COAL FIELD
TO THE
TRANSPORTATION ROUTES AND IRON ORES
OF THE
SOUTH APPALACHIAN REGION.
BY
J. B. HOEING, Topographer.
1886.
Scale: 30 Miles = 1 Inch.

GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

REPORT

—ON THE—

POUND GAP REGION.

percy

By A. R. CRANDALL.

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INTRODUCTORY LETTER.

John R. Procter, Director Kentucky Geological Survey:

SIR: In submitting the accompanying report on the Pound Gap Region, and also the report of Assistant J. M. Hodge, in extension of the same, it seems hardly necessary to recur to the difficulties which have occasioned delays in the publication of the results of field work in the upper counties. Perhaps it is sufficient to say, that while endeavoring to make the best use of the limited time available for field work, I have very *fully* shared in your desire to avoid hasty conclusions, and this especially in a field so important as this proves to be, and one of which so little was previously known. There still remains some uncertainty as to the place in the general section of some important beds. As to this, it may be hoped that work in adjoining localities will supply the data for more satisfactory solutions of such stratigraphical problems.

The discussion of the dynamic geology of this interesting region is limited to the requirements for an intelligent view of the economic geology of the mountain region.

Finally, it has been the aim of the writer, by the aid of diagramatic sections and of photo-engravings, to place in compact form before the reader much that is of special interest as relating to this field.

A. R. CRANDALL,
Assistant Kentucky Geological Survey.

LEXINGTON, KY., June 15, 1885.

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Plate B.

"BREAKS OF SANDY" BELOW TOWER ROCKS.

REPORT ON THE POUND GAP REGION.

The mineral resources of the upper counties are represented chiefly by the beds of coal which, to the number of from six to eight, are found in workable thickness. Enough is now known of this region to warrant the statement that nature has made ample compensation for remoteness from established lines of traffic in both the quality and the quantity of the coal deposits. This will be seen from the sections and analyses accompanying this report. On the other hand, a report on the iron ores must be disappointing, so far as any expectation of large deposits in the coal measures may have been indulged. (See Introduction, page 3.) Reports on the lower counties show an increased leanness in iron ore deposits towards the headwaters of both the Kentucky and the Chattarawha or Big Sandy Rivers. So far as known Pike and Letcher counties are no exception to this tendency, excepting only a narrow belt on the face of Pine Mountain, where, along an extended fault line, ore bearing rocks below the coal measures are brought to the surface. These ores will be described in the proper connection.

TOPOGRAPHY.

The Pound Gap region presents some topographical features which in the lower counties are entirely wanting. These features are the accompanying results of the violent movement attending the formation of the fault-ridge known as Pine Mountain.

So bold an escarpment, extending for nearly one hundred and forty miles across the country, could not fail to give to the adjacent topography many characteristics, of which the mountain itself is the best exponent.

The greater elevation of this mountain barrier, and the abruptness of its face, formed by uplifted rocks along an extended line of fracture, appears at first approach more like an interruption of the topography of the country by the uplifting of a barrier across it after its hills and valleys had been carved out and its drainage established, than like a part of the general result of the erosion of the whole country after the formation of this fault-ridge. Doubtless there is a considerable margin of fact on the side of this first impression, as will be seen by a comparison with the Cumberland mountain. But the time of the formation of this fault-ridge is probably so little removed, comparatively speaking, from the time of the upheaval of the coal measures as a whole to form a permanent part of the continent that it may at least be regarded as a prominent factor in the determination of the drainage before the river systems of to-day were mapped out around it.

From the time of the uplift to the present, Pine mountain has not been less prominent as a mountain barrier than it is to-day. And the drainage of this region has adjusted itself to this prominent feature, making extended detours along the foot of the mountain slope to find outlets to the westward with the general slope of the country. Along the face of the mountain, also, the valleys have fallen into line with the fault, as in the instance of Elkhorn Creek, of the Kentucky River above Whitesburg, and of the heads of the streams in the southwestern part of Letcher county, the same parallelism continues along the whole face. Away to the westward and north the drainage conforms in general to the slight inclinations of the rocks of the coal measures, which illustrate by varying dips, some of the minor movements attending mountain-making.

Pound Gap is at the head of important branches of two great rivers, the Kentucky and the Chattarawha or Big Sandy, which flow in widely different directions, in consequence of the slight, but well defined anticlinal, which extends from the Gap westward. (See on accompanying map the direction of inclination as indicated by arrows.) For this reason Pound Gap, though only cut deep enough for a tolerably good wagon road, is an important point in this long mountain barrier. With the development of railway systems to the East and South, it will become

Plate A.

VIEW AT WHITESBURG, OF VALLEY OF NORTH FK., KENTUCKY R. AND PINE MT.

a more important point of convergence, especially from the valleys of the Kentucky and the Licking rivers, which have for a separating watershed the extension of the Pound Gap anticlinal, as above described.

Pine mountain* extends as a fault-ridge from the Breaks of Sandy, in a general southwest direction, to the Elk Gap, in Tennessee, with but two water gaps in the intervening distance, or three in all, including the Breaks. The relation of Pine mountain to the Black and Cumberland mountains, to the southeast, gives additional importance to Pound Gap, as a possible outlet in that direction. The average height of Pine mountain above the drainage on the northwest is, in Pike and Letcher counties, about 1,600 feet. The southeast slope is about 200 feet less. Some notion of the prominence of this ridge is given by the view up the Kentucky river from Whitesburg. (See Plate A.) Also the view at the mouth of Elkhorn creek.

The termination of the Pine mountain fault, at the Breaks of Sandy, gives to the northeast of this ridge the character of an anticlinal, of no great prominence in the general topography of the region, but still an uplift sufficient to place the upper portion of the conglomerate formation above the drainage, and so to give to the country along its axis the peculiar cliff and gorge topography of this formation. In this character it extends across the country to the Tug Fork of the Big Sandy river, and into West Virginia.

The rocks exposed in the Breaks are all of the conglomerate formation at the base of the coal-measures, and there is shown, by comparatively slight displacements, little of the effects of the profound fault, which, within three miles to the southwest, represents a displacement of not less than 2,000 feet.

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*From the Breaks of Sandy to the Pound Gap or Sounding Gap, as it is sometimes called, the Pine Mountain is known by many as the Cumberland Mountain. This is but one of the instances of confusion arising from local nomenclature. The two ridges, the Pine and the Cumberland, are joined near the Pound Gap by a Black Mountain ridge, separating the waters of the Pound Fork of the Sandy river and the Powell river on the one side from the Cumberland waters on the other. Along this ridge the State line crosses from the Cumberland to the Pine Mountain; but the distinction in both the geology and topography of the several ridges is fully preserved, the Pine Mountain having a westward and the Cumberland an eastward escarpment throughout.

With equal confusion of the geography of the country the northeast extension of the Cumberland mountain is called the Stone mountain.

With the introduction of accurate topographical maps, it may be hoped that correct notions of the geography of this region will prevail.

Little time has been found to study in detail the effects of this sudden change from an anticlinal to a fault-ridge, or the conditions attending the formation of the water-gap at this transition point. The northwest dip of the anticlinal extension of the mountain beyond the Breaks is preserved to some extent along the face of the fault-ridge southward, giving a considerable area along Elkhorn creek and to the west, in which the conglomerate formation and the comparatively barren shales above form the bases of the hills. The fall of the Elkhorn and Shelby creeks is such that these rocks rapidly fall below the drainage towards the headwaters. (See sections, Plate IV.) The moderate dips, westward from the Breaks, do not fully account for the sudden disappearance of the massive conglomerates which form the walls of the Breaks, as noted along the Russell Fork. No fault has been observed crossing the gorge; but it is probable that one exists for some distance north of the Breaks, but to the westward of the line of the main fault.

The Breaks of Sandy, though now almost inaccessible, will, with the advantages of railway transportation, become a point of great interest as an unusually attractive mountain gorge. Plate B. shows something of the character of the Breaks below the towers, which rise to a height of nearly 1400 feet above the river.

The geology of Pine mountain is not complicated by any considerable variation from the simple fault-ridge type of mountain. The average dislocation, by the upthrow of the whole series of rocks, to an unknown depth along the fault line, is about 3000 feet. The rocks exposed in the face of the mountain reach downward and backward in time to the Upper Silurian formation. These lower rocks offer little of economic value for the present, except the iron ores, which will be noticed in their proper place. But they offer important testimony relating to the history of Pine mountain. The formations represented are in the same order as noted along the outcrop of the coal measures. (See report of Lesley on western outcrop of the coal measures, Vol. IV, old series; also report on the geology of Menifee county, Part 4, Vol. C, new series, and other reports by the writer.)

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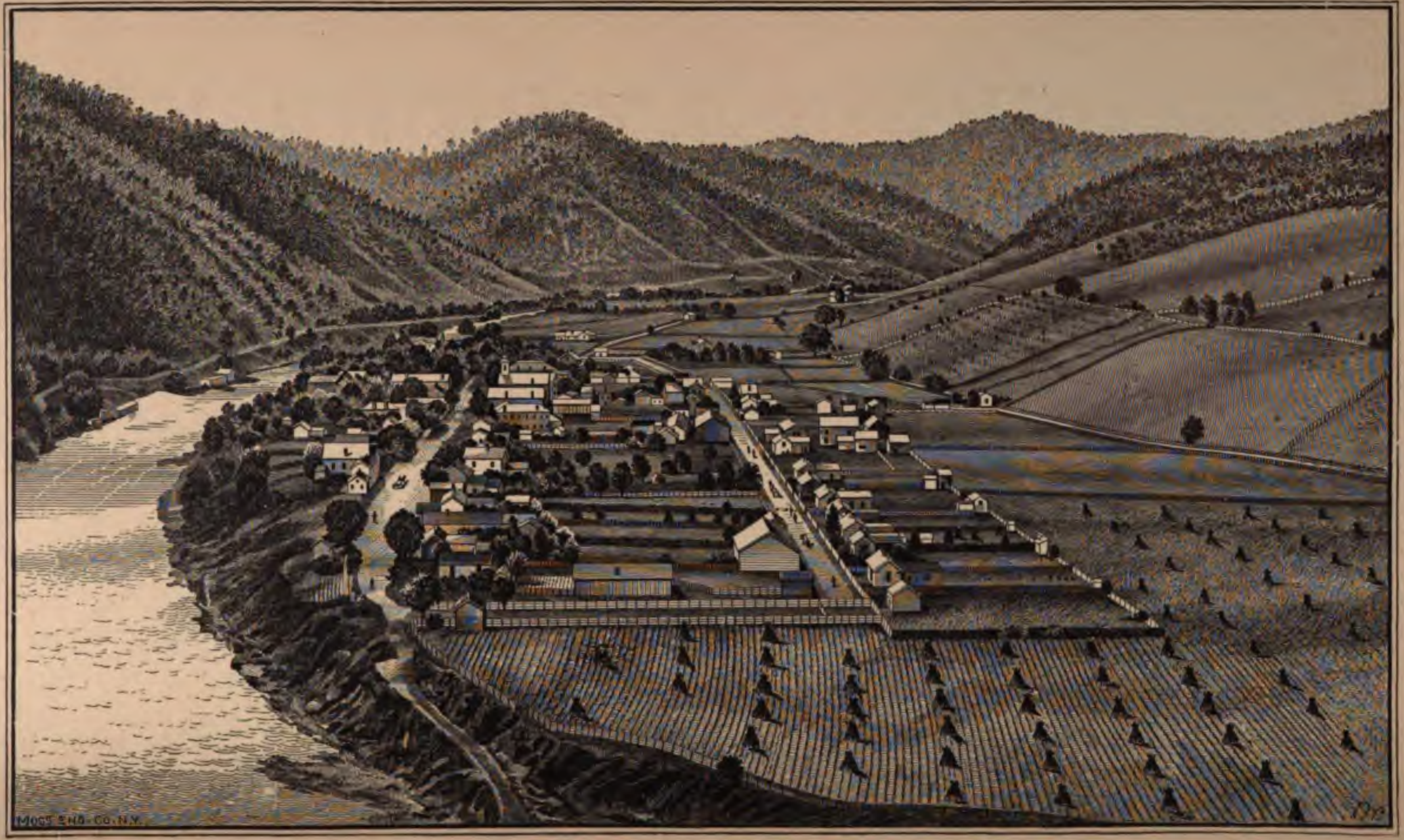
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VIEW AT PIKEVILLE, VALLEY OF THE LEVISA FK.

The following table shows approximately the thickness of the several formations:

	Western Outcrop.	Pine Mt. Region.
	Upper Silurian rocks, 100 to 200 feet	400 feet.
	Devonian (black shales) 65 to 120 feet	150 feet.
Lower Carb.	Waverly Gr., 300 to 600 feet	200 feet.
	Sub-Carb. Limestone, 20 to 400 feet	500 feet.
	Carb. Congl. Sandstone, 10 to 300 feet	2000 feet.
	Measures above the Congl.*	2300 feet.

It is interesting to note the changes in thickness as indicated by this tabular view. Up to the beginning of the Carboniferous proper there is nothing along the mountain axis, as now known, to distinguish it from the wide stretch of rock-forming area on either side; certainly not to the northwest. The thickness of the Sub-Carboniferous Limestone to the east and south is important as indicating a northwest limit to this area, and also as representing in retreat from this limit a long continued period of comparative freedom from most of the disturbing conditions which interfere with the life of a moderately deep sea.

During the formation of the Upper Carboniferous series, the limit of this area appears to have been little changed. But the conditions attending the distribution of rock-material was so modified, and the deposits so accelerated along a subsiding axis, that there begins from the first a distinct history of the belt, which with the subsequent upheaval, and with the ages of erosion which have followed, is now represented by the mountains upon the southeast border of Kentucky.

It is understood that the great thickness of rocks along mountain ranges is no mere coincidence; but, on the other hand, that the great accumulation of rock material upon the sea floor along an extended axis, carries with it the antecedent conditions for mountain making. These mountains are, therefore, as indicated by this tabular view, Carboniferous in a wider sense than is comprehended in the mere time of final upheaval to form a part of the continent. Pine Mountain as a fault-ridge, must, however, be regarded as having its origin later than the Carboniferous Age.

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*The original thickness of these rocks at the present outcrop would be the thickness that has been worn away, as also the original thickness in the Pine Mountain region would be 2300 feet with the thickness removed by erosion added. No reliable estimate of extent of the erosion in either locality can be made as yet. It is probable that it has been greater along the border of the coal-fields, but not enough to indicate an approach to the thickness in the upper country.

The first stage in the history of these mountains was also a part of the history of a wide and shallow channel of the sea as formed by the older mountains of North Carolina on the one side, and by the Kentucky Anticlinal of the Silurian Age, extending through what is now Central Kentucky, on the other.

This is not the place to discuss the actual limit of the Carboniferous deposits westward, or the possible connection of the Eastern with the Western coal-fields across the Bluegrass region by coal-bearing rocks, which may subsequently have been worn away. That which is of importance in this connection, is the fact that to the northwest, as also probably to the southeast, from the line of thickest deposits and of the greatest successive subsidences, these movements and these deposits were evidently less and less towards an axis of little movement and of minimum deposits during this part of the history of the coal-measures. This, with the ordinary variation of conditions over so wide an area, will serve to explain the want of similarity between the sections in the lower counties and those of the Pine mountain region. It is not unlikely that, conforming to the shortest distance to the southeast sea shore, a much more rapid thinning out should be assumed to have facilitated the wearing away of the whole Carboniferous series beyond the crest of the present Cumberland mountains.

The accompanying profile section of the Pine, the Black and the Cumberland mountains show the order of geological formations in these mountains, and for the Pine mountain substantially the relation of beds to the drainage throughout its length. There is also shown some interesting facts in the later history of these mountains. Whatever the fact may be as to the axis of these mountains, as indicated by the line of the greatest Carb. deposits, it is evident that the Cumberland mountain represents the line of final uplift, so far as it is now represented by Carboniferous rocks.*

But the crest of the Cumberland mountain has been carried back several miles from this line of upheaval, while the Pine Mountain has receded but a little from the fault-line which

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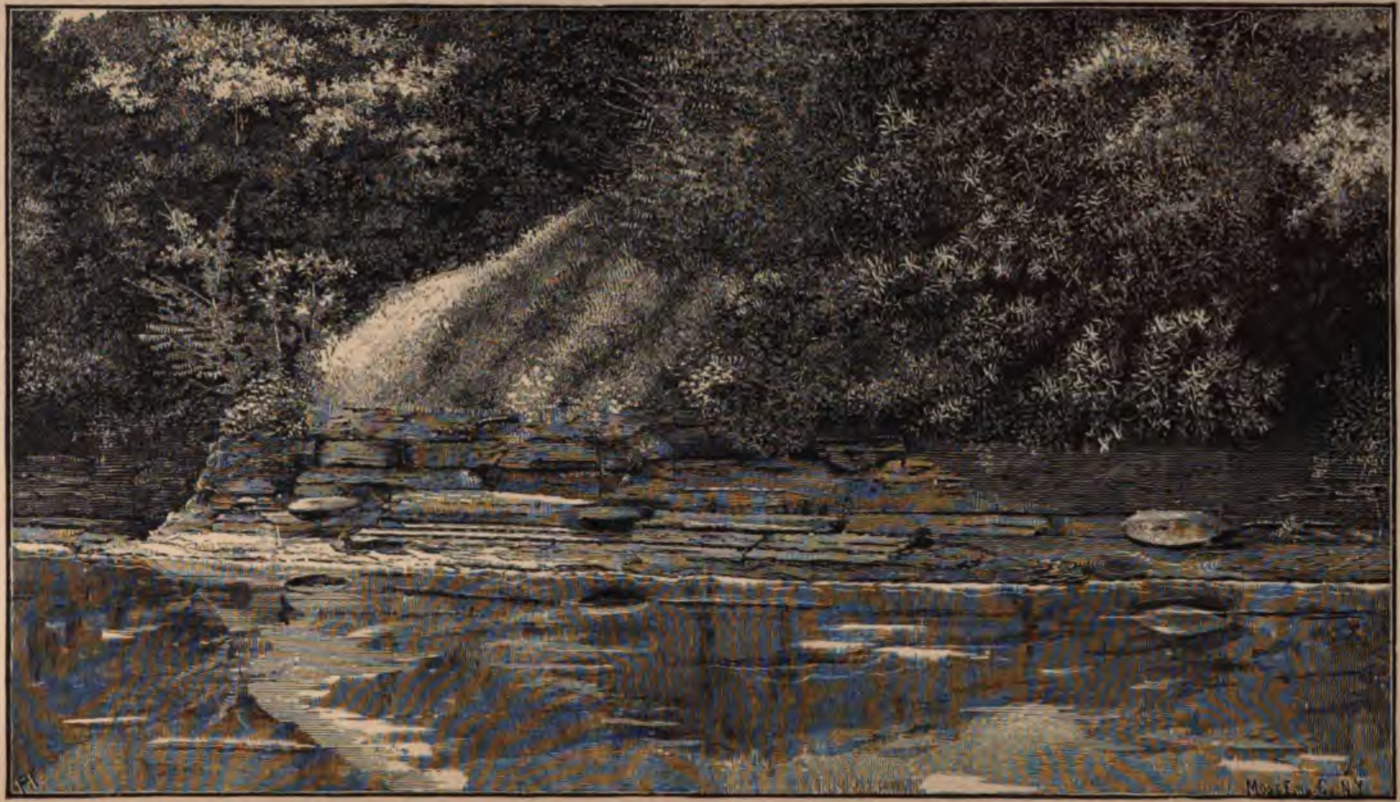
*There are some reasons for supposing that this anticlinal, along which in this region only Silurian rocks are now exposed. has an earlier origin than the close of the Carboniferous Age. This is not, however, the place to discuss this point, it being in no way essential to the purpose of this report.

Plate C.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CALCAREOUS CONCRETIONS IN SHALE ROCK, CARR FK., LETCHER CO.

marks the starting-point as a receding crest. Hence this fault-ridge has been described as of much more recent origin than the Cumberland anticlinal.*

But the great contrast in these receding escarpments should not alone determine the comparative lateness of the formation of the fault-ridge. The synclinal slopes of these mountains show about an equal progress of the wearing agencies. The general inclination of the rock-beds being about the same in both mountains (15 to 25 degrees), or, if there is any difference in dip favoring erosion, it is with the Cumberland slope. This fact should greatly qualify the inference drawn from this striking contrast in the two receding crests. The truth lies between these conflicting records. And whichever indication may be regarded as most important, the harmonizing of the two must be regarded as emphasizing very greatly the effects of varying exposure to the sun. The face of Cumberland mountain and the slope of the Pine are fully exposed to the direct rays of the sun, while the slope of the Cumberland and the face of Pine mountain present northward exposures. It is, doubtless, very largely owing to this that the very great inequality in the retreat of the two crests is set over against the equal erosion of the synclinal slopes. The erosion of the receding wall of the Cumberland and of the Pine mountain slope has been greatly accelerated by more frequent and more effective alternations of sunshine and frost. The same effect is prominent in the valleys along the fault line of the latter mountain. These valleys are to the northward instead of to the southward of the fault line, as should have been expected from the well-known acceleration of erosion with increased dips, other conditions being equal.

It still remains that the Pine mountain fault is considerably later in time than the Cumberland uplift. It is undoubtedly a sequence to the general movement attending the formation of the latter mountain.

THE IRON ORE OF PINE MOUNTAIN.

As indicated by the accompanying profile section, two regular iron ore horizons are brought above the drainage by the

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*Prof. N. S. Shaler. Vol. III, New Series, p. 224; also report on the region adjacent to the Kentucky and Virginia State-line, by P. N. Moore, Part 4, Vol. IV, New Series.

Pine mountain uplift; the same that are exposed by the cutting away of the overlying rocks along the front of the Cumberland mountain. The Limestone ore of the profile section is the same as the Red River ore, which falls below the drainage in the western border counties of this coal-field. (See report on the Red River Iron district, report on the Iron ores of Greenup, etc., also report on the Geology of Menifee, Vol. C., reports on the Eastern coal-field.) Not much is known of the thickness and persistency of this ore in the Pound Gap region, as it is usually covered by the soil and mingled fragments of rock, which cover the face of the mountain to a considerable depth. It is seen at many points in a weathered state upon the surface, sometimes, as at the heads of Pigeon-roost Br. and of Toms Br. of Elkhorn creek, in a spur of Pine mountain it is exposed in great profusion over the surface.

The quality of the ore is not inferior to that of Estill and Menifee counties. Whether it is thick enough for profitable mining, dipping as it does into the face of the hill, is a question to be settled by practical tests. The surface indications are favorable, but could not be held as conclusive except as to the equivalency and the uniform good quality of the ore.

The Upper Silurian, or Dyestone ore, may, with reasonable certainty, be assumed to occupy its regular place in the beds at the foot of the mountain, as indicated by the profile section. In this region it is everywhere covered by the abutting coal-measure rocks or by the talus from the ledges of overlying rocks. The tendency of the valley to wear away from the face of the mountain leaves a foot wall of horizontal Carboniferous rocks the whole length of the ridge, except at the water-gaps. And, contrary to the occurrence in the Cumberland mountain, the water-gaps are at points of least upthrow, so that the ore is not exposed the whole length of the mountain except at Elk Gap, (Safford.)

Along the face of the Cumberland mountain none of these conditions stand in the way of a study of the ore, which occurs in several beds, or interferes with the ready mining at many points far north and south. The time may not be far distant, however, when it may be desirable, even at greater expense, to develop this ore in connection with the coking coals, which are being developed west of the Cumberland mountain.*

On Elkhorn creek another ore occurs which does not belong to the Pine mountain series; but as it is a local deposit along the face of the mountain, it may properly be described in this connection. This bed has the character of a recent deposit, though its occurrence at many points along the valley on both sides of the creek at the same horizon, apparently, and the similarity of the arrangement of the parts of the bed at widely separated exposures, make it appear like a continuous bed. It is made up of from one to three feet of anhydrous sesqui-oxide of iron, including many fragments of sand-rock and siliceous shale, the latter, apparently, greatly changed by heat. The ore is also in part blistered and porous, as though through the agency of heat. Resting on this there is generally found from one to two feet of earthy ore, or red ocher, with small fragments of siliceous rock intermingled. In general, the lower part includes too great a proportion of siliceous material in the form of fragments ef sand-rock to be valuable. In places, as noted near Levi Potter's, it will probably be found comparatively free from these objectionable features. An analysis made at the Labratory of the Survey of a sample from this place shows the following results:

Moisture	1.060
Iron per-oxide	59.630
Alumina	7.927
Phosphoric acid	.563
Phosphorus	.234
Siliceous residuum	29.73
Metalic iron	41.74

It is probable that this ore is a rim deposit, but nothing has been noted which explains its occurrence at this particular horizon; and the appearance of metamorphosis cannot be readily explained from the data at hand. No indications of heat in connection with the Pine mountain fault have been observed at any place. But if this ore is a rim deposit, it is, doubtless, of later origin than the fault-ridge, and as it extends laterally across the valley in association with the undisturbed coal-bearing strata, there is apparently no good reason for supposing that this ore has at any time been subjected to a high degree of heat, unless a burning coal-bed be assumed to have been the source. Locally coal-beds in this region are found to be burned out for a considerable distance under ground, but no indications of a coal-bed have been seen at this level. The most that can be said for this ore is, that it is probable that it may prove valuable as an iron ore locally, and generally as a source of red ocher. It is exposed along the Elkhorn valley, from near the mouth of Sycamore Creek towards the head for six miles or more. On Pigeon-roost Branch it is 285 feet above the main creek. On Harvey Gibson's land, opposite side of the valley, about the same level. It is relatively lower up the creek, being 150 feet above the main drainage at Levi Potter's.

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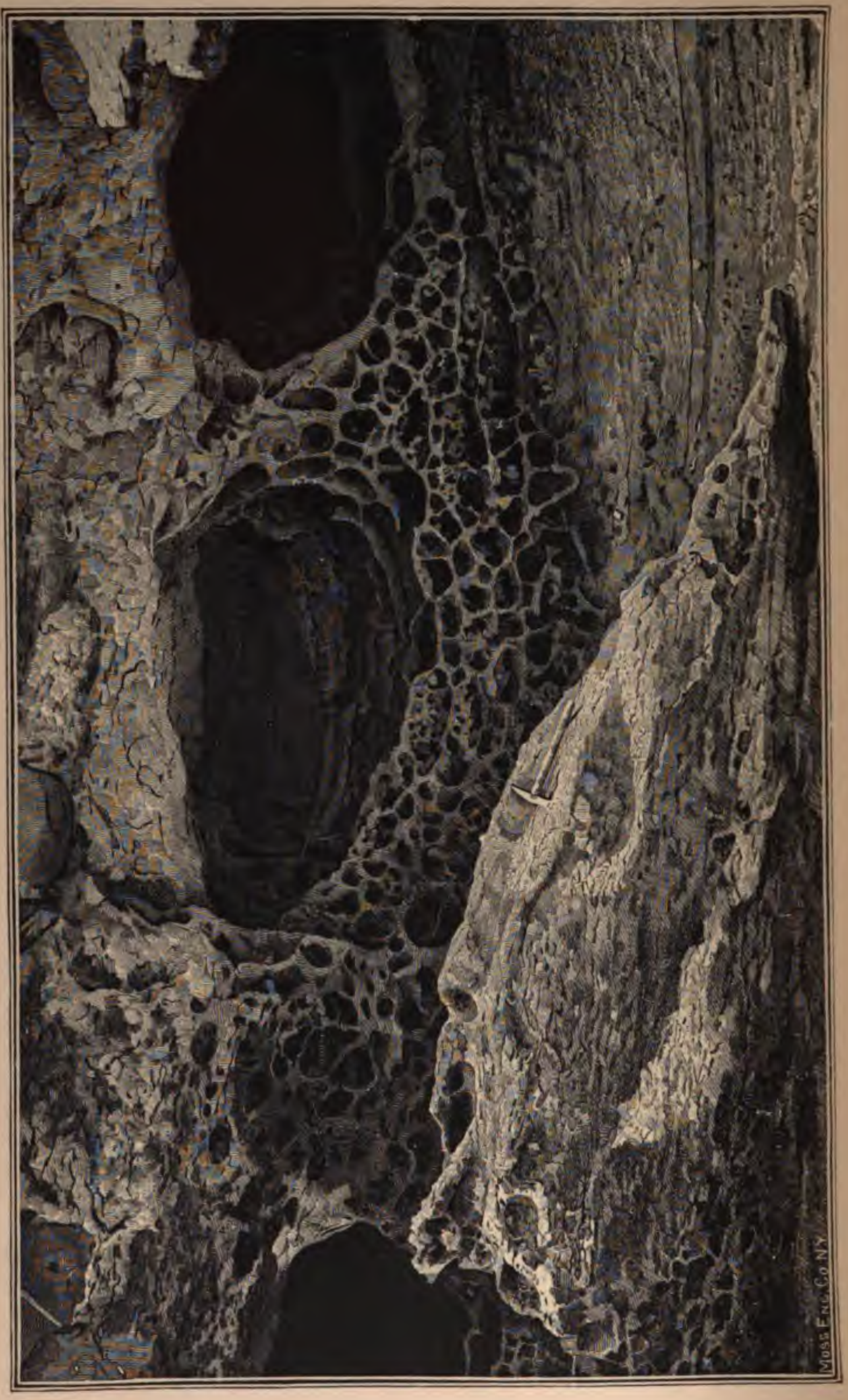
*For description of the Upper Silurian iron ores see report of P. N. Moore on the Iron Ores near Cumberland Gap, Vol. C., Reports on the Eastern Coal-field; also Vol. IV, New Series.

COAL BEDS.

The coal-bearing rocks of this region are, as a whole, continuous with those of the lower counties. The series is greatly thickened, and includes an increased number of coal beds, but, as already indicated, presenting a section so different as to make the recognition of coal beds as continuous with those in the sections of the lower counties difficult, if not impossible. The progressive changes in the general character of the rocks in Lawrence and Johnson counties, as mentioned in the report on that region, are suggestive in this connection, but only a study in detail of the thickening series, from the outcrop to Pine mountain, can give a full solution of the question of equivalency of beds in the Eastern coal-fields.

There are some features that have been traced across the whole field which serve to indicate in a general way the relations of the parts of the vertical section in the different portions of the field. The shales above the conglomerate, fifty feet thick in the western part of Greenup, and 150 feet in Lawrence, are readily recognized on Elkhorn and Shelby creeks, in Pike county, with a thickness of 450 feet. Elsewhere in the Pound Gap region only a part or none of this portion of the section is above the drainage.

Plate D.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ROCK-HOUSE NEAR PIKEVILLE, KY.

The first persistent coal of importance above the conglomerate formation is towards the top of these shales, in the latter as well as in the former region. The occurrence of calcareous concretions, which become abundant in Lawrence county, associated with coals 1 and 2, is even more noticeable in the Pound Gap region along with the coals of the same general level, here increased in number to four beds or more. These concretions are prominent in many localities, and at levels ranging through 300 feet of vertical section. (See Sections 7, 8, 13, 18 and 27.) They appear generally as lenticular earthy calcareous segregations, varying in size from a few inches to fifteen feet in greatest diameter. In some instances they are fossiliferous, and in many instances they show a well-defined concentric structure. Less frequently these calcareous deposits appear as more or less regularly jointed layers, or as continuous beds. Plate C shows some of these lenticular bodies as imbedded in the slaty shale at the top of the shale series on Carr's Fork of the Kentucky river, at Kelly's mill, in Knott county.

The section above is not so easily comparable with what may be supposed to be the corresponding part of the general section in the counties near the border of the coal field. There are some points of resemblance; and some features have been traced with some degree of certainty, across the intervening territory. But the requirements of this report will doubtless be satisfied without urging the matter of equivalency beyond these general statements.

There appears to be no workable beds of coal either below or in the conglomerate series of this region. There are no exposures to show the thickness of the sub-conglomerate shales. From the surface indications along the face of Pine mountain it is probable that less than fifty feet of the general section is occupied by these beds, which along the border of the coal field are relatively much more prominent, and at some points, as in Menifee county, include a workable coal. (Vol. IV., Part II., and Vol. C.) The conglomerate formation has a maximum thickness of 2,000 feet, made up of coarse ferruginous and more or less conglomeratic sandstone, alternating with shales in such a way as to form five or six benches where the whole series is exposed. Cross-bedding is a noticeable feature throughout the formation. Quartz pebbles varying from the smallest to one-half or three-fourths of an inch in diameter, are somewhat irregularly prominent, forming what in that region is spoken of as hailstone grit; a rock from which millstones of good grinding quality are made. Thin beds of coal have been noted at points widely separated, as at the Breaks of Sandy, in the lower benches as exposed along the river; and on the Pine mountain, south of Whitesburg. Professor Stevenson finds six thin beds at Pennington's Gap, in this group (Geological Reconoissance of parts of Lee, Wise, etc., Va.); and it is not unlikely that something like the same number would be found in this region if all the shales could be examined. On the re-appearance of this formation to the southwest in the region of the south fork of the Cumberland river, several inter-conglomerate coals are workable beds. (See forth-coming report on the coals of Pulaski and Whitley counties.)

The first coal bed of more than local importance, beginning at the base of the series above the conglomerate group, is also the No. 1 of previous reports. It is above the main drainage in most of the region included in this report; and it is traceable with a reasonable degree of certainty from the Graham coal of Carter, to the Paintsville coal of Johnson, the Warfield coal of Martin, the Prestonsburg coal of Floyd, and so to the head-waters of the Chatterawha or Big Sandy, and of the North Fork of the Kentucky. On Beaver creek this bed has a thickness of from three to five feet; the maximum being found, in the valley of the Right Fork, from the mouth of Rocky Fork, to Caney creek, including portions of the valleys of all the tributary streams of this locality. Enlarged Sections 1 and 6, Plate VII., show the general character of the bed in this region. The cannel coal, as represented, is probably limited to a small region; extending along the main creek less than one mile and extending for a short distance up Stone-coal creek and for a mile or so up Rocky Fork. On Dry creek, near the mouth and near the locality of Section 9 (see figures on the accompanying map which indicate localities of sections as numbered) a few inches of cannel is again shown as a part of this coal. The thickness in this locality is four feet of good coal. (Section 9, Plate II.) Toward the head of the creek it is reduced to three feet or less. (Section

Plate F.

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BLACK WALNUT, FLOYD CO. 21 FT. CIR. AT BASE.

6, Plate II.) On the Left Fork of Beaver creek the bed, as a whole, is considerably increased in thickness (Section 7, Plate II.), but with only forty-three inches of coal available for mining from the thickness of shale partings. On the river in the Laynesville region and on Mud creek a seam of unusual thickness (Section 11, Plate VII.), twenty to forty feet above the river bottom, probably represents this bed. In the Pikeville region this bed is represented by the lower coal on Little Chloe creek—Sycks' coal. (Section 1, Plate I.) On Shelby creek the Jackson Newson seam, on Robinson, fifty-three inches, including eight inches of shale, Keel's and William Hall's coals on Indian (Section 13, Plate III.), and possibly Tacket's coal on Long branch of Indian, fifty-one inches, including a six-inch parting, represent this bed. It is possible, however, that the latter coal is the Elkhorn seam higher up. On Elkhorn creek this bed is probably represented at its best by the sixty-five inch coal, as shown near Wade Sanders' on Sycamore creek. (Section 16, Plate VII.) From the numerous openings made by Mr. Broas on Elkhorn, this seam would appear to have an average thickness of about forty-four inches. On the head-waters of the Kentucky river, the main lower coal of Colly, Sand-lick, and Dry creek, and of Rock-house creek, above Little Colly, appears to represent this bed. (See Sections 18, 20, 21, 23, 25, 26, Plates IV., V, and VI.) Near Pound Gap, and also in the southwestern part of Letcher county, this coal bed is below the drainage level.

This coal seam varies greatly in thickness, and especially in the matter of partings. It is a good coal, however, throughout, and in some parts of this field it is the main coal.

The following analyses of samples which represent as nearly as practicable the whole bed, show the character of the coal in the different parts of the field:

Table of Analyses of the Lower Coal of the Pound Gap Region.

	Spec. gr.	Moisture.	Vol. Comb. Matter.	Fixed Carb.	Ash.	Sulphur.
Thompson's Sand-lick C. upper bench	1.191—	1.10	40.90	55 40	2.60	1.453
Thompson's Sand-lick C. lower bench	1.279—	1.10	34.30	57 20	7.40	.889
Caudill's C. 2 M. below Whitesburg, upper bench	1.277—	1.30	39 60	55 20	3.90	2.812
Caudill's C. 2 M. below Whitesburg, lower bench	1.286—	1.60	36.40	56 60	5.40	1.060
Collins' C. Rockhouse Cr	1.242—	1.46	35.84	58.60	4.10	1.068
Wm. Hall's C. Indian Cr., Pike Co	1.294—	0.60	33 94	59.46	6.00	.876
Jackson Newson's C. Robinsons' Cr	1.311—	1.00	34.20	58.90	5 90	.903
Syck's C. Little Chloe Cr	1.367	5.06	29.84	57.50	7.60	1.038
Mo. Mud Cr. Hatches C. upper part	1.302--	2.04	37.42	56.34	4.20	1.475
Mo. Mud Cr. Hatches C. lower part	1.281—	2.10	37.16	57.74	3.00	.596
Laynesville C. upper 23 inches	1.359—	1.30	36.70	51.70	10.30	1.356
Laynesville C. lower 45 inches	1.284—	1.90	35.30	58.94	3.86	.715
Laynesville C. lower 45 inches Coke open heap	....	0.60	...	94.70	4.70	.835
Martins C. Mo. of Steele Cr. Floyd Co	1.323—	2.50	32 50	56.54	8 46	.651

In Letcher county a bed of coal having in places a thickness of thirty inches, is found twenty-five to thirty feet below the Sand-lick seam. (See Sections 18, 20, 21 and 26, Plates IV, V, VI.) This is the coal mined back of the school-house at Whitesburg, and also at Combs' store, on Rockhouse creek, at the mouth of Trace branch, but little above the bed of the stream. A thin bed has been noticed at several points in Floyd and Johnson counties, in a similar relation to the main lower coal. (Coal 1.) Above the Sand-lick coal, sixty to one hundred feet, as shown in Sections 17, 18, 19 and 22, is another coal-seam like the previously described bed. It is mined for local use at one point only in this region—at John Wright's, near the head of Elkhorn creek, in Pike county. It may be seen, however, at many points, varying from one to three feet in thickness, and is persistent enough to be regarded as one of the regular beds of the region about Pound Gap. (See Analysis (a) general table.) Its relation to the next coal above is so nearly like that of the previously described bed to the main lower coal, that in some places one of these horizons may easily be mistaken for the other.

The next coal in the series, is probably the most important bed in the Pound Gap region. Better known on Elkhorn creek, in Pike county, than elsewhere. From developments begun there, this bed has come to be known as the Elkhorn coal. In the Big Stone Gap region, in Virginia, this bed is known as the Imboden seam. It is also known as the "Coking Coal" of that region, a designation which is applicable in the Pound Gap region from the coking qualities of the coal, as will be seen from such preliminary tests as have already been made. The area of the Elkhorn coal in its recognized character, includes, in a general wav, the headwaters of Elkhorn and Shelby creeks in Pike county, of Beaver creek in Floyd and Knott counties, and of the Kentucky river in Letcher, including Millstone and Thornton creeks, the head of Rockhouse creek and also the head of Carr fork, in Knott county.

The openings made to develop this coal are mostly in Pike county and the adjoining part of Letcher. Plate VIII, A, shows its thickness and surroundings at a number of points, as measured at test openings driven to roofrock.* The place of the Elkhorn coal is at the top of the shale series, as previously described, and it therefore falls below drainage in the southwestern part of Letcher. It is so reduced in thickness and changed in character in this direction, however, so that it can hardly be regarded as one of the workable coals. The same is apparently true to the northward of the field, as imperfectly outlined above.

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*The greater number of these openings were made by Mr. R. M. Broas, for parties represented by him, at an expense which could not by any possibility have been met by the Survey; and it is but justice to say that this work was generously shaped to facilitate the investigations of the assistants of the State Geological Survey in this region. Workmen were also furnished by Mr. Broas to cut out the column for the Louisville Exposition, under the direction of the writer.

Though one of the large bodies of coal in the eastern field, as seen from sections, Plate VII, B, the chief importance that attaches itself to the Elkhorn coal, distant as it is from established lines of transportation, is in consequence of the coking qualities, which are found to be a leading characteristic of this bed. Tests in this direction have not been made for the whole body of coal as described; the unusually uniform character of the coal, as indicated by the accompanying table of analyses, goes very far, however, towards establishing, for a large territory, the superior coking qualities, which are shown by the tests in the Elkhorn region. Little comment is necessary on the results of coking tests, as given in the table which follows. The difficulties in the way of thorough investigation have been very considerable. Coking in small open heaps, even under the most favorable conditions, can hardly be supposed to secure the best results, and the transportation of large quantities of coal has not been practicable. Results in ovens have, therefore, been limited to a few bushels placed in wooden cases, along with the ordinary charge in regular coking ovens of the beehive pattern. To this method there are some objections, which could, however, hardly be regarded as detracting much from results uniformly better than the regular product of the ovens made use of. Two large boxes of Holcomb's coal, on the head of the Kentucky river, were shipped for additional tests in ovens, but were destroyed by the way along with other valuable collections. The results presented, though not so complete as might be desired, fully sustain the first views expressed respecting the Elkhorn seam as a most promising coking coal.

Analyses of the Elkhorn Coal and Coke.

COAL.	Spec. gr. . .	Moisture. .	Vol. Comb. Matter. .	Fixed Carb.	Ash. . .	Sulphur . .
Holcomb's C., near head of Kentucky river, whole seam	1.291—	3.26	32.24	61.60	2.90	.656
Holcomb's C., near head of Kentucky river, lower 68 inches.	1.319—	2.86	31.54	62.10	3.50	.535
Mullen's C., near head of Elkhorn cr., whole bed	1.282—	2.60	34.20	60.80	2.40	.412
Mullen's C., near head of Elkhorn cr., lower part.	1.271—	2.00	33.50	60.54	3.96	.429
Cane br. of Elkhorn cr., upper part. .	1.355—	6.00	31.26	59.34	3.40	.390
Cane br. of Elkhorn cr., lower part . .	1.314—	2.54	32.26	62.20	3.00	.547
Mill br. C., of Elkhorn cr., upper part.	1.271—	1.60	29.36	67.40	1.64	.610
Mill br. C., of Elkhorn cr., lower part.	1.278—	1 60	32.10	64.64	1.66	.711
Bear Fork of Robinson cr., upper part.	1 294—	0.40	33.20	62.46	3.94	.642
Bear Fork of Robinson cr., lower part.	1.273—	0.40	34.80	60.46	4.34	.711
Fleming's cr. C., ...	1.350—	3 80	33.80	60.60	1.80	.475
Imboden bed, Virginia	. . . .	1.38	35.92	60.59	1.51	.594
Mill br. C., (coked at Connellsville) . .	. . . .	1.80	26.80	67.60	3.80	.967
COKE.						
Mill br. coke, open heap	. . . .	2.86	. . .	88.44	8.70	.844
Mill br. coke, in oven, Cincinnati . . .	. . . .	0.20	. . .	93.20	6.60	.734
Mill br. coke, second sample in oven, Cincinnati.	. . . .	0.06	. . .	94.34	5.60	.788
Mill br. coke, in oven, Connellsville .	. . . .	1.20	0.60	94.14	4.66	.906
Mullen's cr., coked in open heap, upper part	. . . .	1.10	. . .	95.40	3.50	.517
Mullen's cr., coked in open heap, from whole bed	. . . .	1.06	. . .	90.40	8.54	.598

The physical properties of the Elkhorn coke have not been studied in detail, and in fact, the conditions have not been possible for a complete comparison with the standard products of established coking industries of the country, for reasons which have already been stated. The coke obtained by the two methods as described above appears to have the requisite strength for all furnace purposes. It has a bright metalic lustre, and is porous enough for free combustion in the furnace. In the last respect the results of experiment at the laboratory of the survey are not without interest.

For comparison with the standard cokes of Pennsylvania, so far as that has been attempted, the plan adopted was that based on the inch cube of average coke, subjected to tests by weight dry, and filled as perfectly as practicable with distilled water, by the aid of the air-pump. The coke used was made as above in a Cincinnati oven, reducing by the formula indicated by the tabular statement of the Pennsylvania report (Vol. L, pages 82 and 128). An average gives the following comparative results:

	WEIGHT IN GRAMMES.		PERCENTAGE.	
	Dry.	Filled with Water.	Coke.	Cell Space.
Pittsburg & Con. Co. Coke.	12 46	20 25	61 53	38 46
Elkhorn Coke.	12 59	20 688	61 71	38 24

This comparison shows a striking similarity to the well-known Connellsville coke, which may fairly be regarded as standard.

But while this statement is correct enough for a comparison of the physical structure of the two cokes in this respect, in order to get a correct notion of the actual structure of standard cokes, it should be noticed that the assumption on which the determination of the per cent. of cell space to the coke is based, is very far from a correct one. For the increase in weight by filling the cells with water, is in the one case 8.098 grammes, and in the other, 7.79 grammes; equal to nearly one-half cubic inch of water, indicating nearly 50 per cent. of cell space. Or, accepting the cubes and the weights as correct, in the Connellsville coke the per cent. of cell space to solid coke is 47 to 53, and in the Elkhorn coke the per cent. is 49.5 to 50.5.

Determinations of the specific gravity of the Elkhorn coke play also an important part in this line of experiment. Repeated trials show some variations in results; but a close approximation to the true specific gravity is found to be 1.72, instead of 1.53, which should be the specific gravity if the above determination of the percentage of cell space to coke be assumed to be correct for an exact cubic inch. This would increase the cell space in the Elkhorn coke to nearly 55 per cent.; and indicates for the Pittsburg and Connellsville Co.'s coke about 53 per cent. Corrections for the inexactness of cubes used would modify these figures somewhat, but these findings are still apparently below the actual percentage; for, as is found by observation and experiment, this increase in the per cent. of cell space represents very largely the extent to which the external pores are emptied on removal from water for weighing by the first method.

And it does not in any way represent the error that arises from the fact that some of the cell spaces within will be imperfectly filled, as a rule. This last is shown in every effort by long continued and repeated exhaustion under the receiver, with long continued immersions in water under the normal pressure of the atmosphere, and under pressure, to reach a final limit of the absorption of water.

These results though presumed to be correct in principle, must, however, be regarded as close approximations only, as will be seen by those who have made repeated tests under even the most favorable conditions of uniformity in density of representative samples, and of success in the filling of cell spaces with water; neither of which will be assumed with unqualified certainty by any one who has pursued this line of experiment. The

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Soon after beginning these tests it was presumed that no more water would adhere to the cube on removal from immersion than would fill the surface pores; and on the other hand it was assumed that the adhering water would, with sufficient accuracy, represent by weight the partially filled cells at the surface. Later, it was found that this assumption was a source of error. The limit of this error has not yet been accurately determined; but the examination of the surface when first taken from the water, by the aid of a magnifying glass, shows very clearly that the source of error here is too great to be neglected in the determination of per cent. of cell space.

It may be added that results obtained on this point indicate an error from this cause, amounting to about 2.5 per cent.

A detailed account of experiments covering this point and others involved in the determination of the porosity of coke, will be given as soon as the series of tests necessary for more specific results have been completed.

It should be stated, however, that after the above series of determinations had been completed, a parallel series of experimental determinations for the Elkhorn coke was begun, from which the following results (subject to correction) are obtained:

(1) Weight of cubic inch of coke (corrected for vol.)	12 87 grammes.
(2) Weight of same filled with water (cor. for vol.)	21 46
(3) Weight of same in water (corrected for vol.)	5 52
(4) Loss of weight (2) by drainage from surface	.42
Specific gravity	1 75
Per cent. by vol. of coke	47 5
" " " cell space	52 5
" " " " " cor. for loss (4)	55 0

Correction of volume was made by carefully sealing the surfaces of the cube and measuring by displacement.

range of variation is so great, however, in the physical character of cokes from different coals, that pursuing the same method of investigation with each, conclusions of real significance and of practical value can be made as in the table above. To make the comparison most satisfactory the coking should be done under similar conditions. This has not been possible in this instance as has been explained, and the margin for error in this respect is understood to be limited only by such care and judgment as the writer and other assistants of the Survey have been able to exercise in the several stages of the work.*

The coals of the sandstone series, above the Elkhorn seam, are rarely exposed without excavation, and great difficulty has attended the work of determining the serial relation of beds which could be examined at wide intervals only at best. Some of these beds are persistent, and retain characteristic features over large areas. Others, though probably continuous seams, are greatly changed in appearance and surroundings, from place to place. Several coal beds are found only in exceptionally high points in the several counties. In so large a field, and one so entirely undeveloped, it would not be surprising if some bed has been overlooked. The greatly varying intervals between beds, and the varying character of the intervening rocks, has added to the difficulty of the work. It is impossible, therefore, as yet, to present a general section for the whole Pound Gap region which is entirely coherent in all its parts.

The first coal of importance above the Elkhorn is a splint and cannel seam on the Kentucky river waters. On the Big Sandy side of the water-shed it is less constant in character, but generally present. This bed marks the lower cannel coal hori-

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*Since this report was written a paper has come to hand, by Mr. F. P. Dewy, of the Smithsonian, on the "Porosity and Specific Gravity of Coke," the result of a more extended and accurate study of some of the physical properties of coke than has heretofore been made. The average specific gravity of the various Connellsville cokes is found by Mr. Dewy to be 1.74, and the average porosity 46.92 per cent. of the volume, the maximum being 57.21 per cent.

These findings, though reached by a method different in part and in some respects more direct than the one adopted here, confirm the results given in this report.

A slight increase in porosity obtained by the method pursued at the Laboratory of the Kentucky Geological Survey, by an estimate of water lost from the surface cells by drainage, a difference amounting to about 2.5 per cent., as explained in a foot note on page 23. This would apparently increase the average porosity of the Connellsville cokes to about 49 per cent., or in general terms, taking the Connellsville cokes as standard, the proportion by volume of cell space in the best metallurgical coke is nearly 50 per cent. instead of 33 per cent., as given by Fulton in Vol. L, Pa. Rep.

MOSS ENG. CO. N.Y.

YELLOW POPLARS, (TULIP TREES) HD. OF CAMP BR., LETCHER CO., KY.

zon of Letcher and Knott counties, though it is more generally a splint or common bituminous coal, with a smaller proportion of cannel, which in places becomes a prominent part of the bed. (Compare Sections 22, 23, 25, 27 and 28). It is exposed at other points in the region represented by these sections, and also westward—notably at Esq. Cornet's, on Carr's Fork, at the mouth of Sassafras creek, where it shows an excellent splint coal fifty-four inches thick, including two or three inches of "bone coal." On Wolf-pen branch of Carr's Fork this bed is opened at John Ambergy's, showing above a five to six inch clay shale, parting thirty-four inches of common bituminous coal, and below, twenty-six inches of very excellent cannel.[*] (See enlarged section, Plate VII, A.) The rocks between this bed and the Elkhorn coal have an average thickness of about 140 feet, mostly thin bedded sandstone, generally forming a well-marked shoulder along the hill-side. Sometimes, besides the thin coal just above the Elkhorn seam, a thin bed of coal may be found in shales, which replace part of the sandstone ledge, separating it somewhat irregularly into two parts.

On the waters of the Big Sandy this bed is represented by the nine feet coal, with many thin clay partings; Section 19, probably by Marrs' coal; Section 10, the twenty-two inch coal; Section 6, the corresponding thirty-nine inch in Section 5; and in the Pikeville region, Marrs', Swords', the upper Chloe creek, and Gillam's coal (Sections 1 to 4), though possibly the two former beds in this last region belong higher up, representing the "upper splint" next to be described. Down the river the lower splint coal is found, showing at a few points only, 200 and 250 feet above coal No. 1, of Floyd county, as on Sugar-loaf branch, five miles above Prestonburg, at Mr. Gobble's. Here the seam is again mostly splint, and it appears to be about four feet thick. Analyses of samples from some of these points are given in the table (*c* to *k*, inclusive). (For the extension of this coal westward into Perry and Breathitt counties, see accompanying report of Mr. Hodge).

One hundred feet or more higher in the series is found another splint and cannel seam, as shown in Sections 10, 11, 12,

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[*] It is possible that Collin's upper coal, Section 20 and the equivalent bed in Section 21, fall at this level; but is more likely that they represent the next bed above, the "upper splint," though the middle coal of Section 21 appears to be the Elkhorn seam.

14, 20, 21, 25, 26 and 28. Next to the Elkhorn this appears to be the most important bed in the Pound Gap region. By way of distinction, it has come to be known to some extent as the "upper splint," a name that is descriptive for only a part of the area over which it has been traced. It is mined on Cowan ridge, opposite Whitesburg, by Mr. Nickles, for the the grate. It has here an average thickness of forty-six inches of free burning coal, which is hard enough to bear handling without the usual amount of waste. The same character, with increased thickness, is shown in the Smoot and Dry creek regions. On Thornton creek it shows, indifferently opened, three feet of coal. The thickness of Collins' upper seam, which is referred to this geological level with some doubt, is given as reported by Mr. S. Kiser, who was employed to face it up. (See enlarged section, Plate VII, A.) The upper bed, at the old place of Dr. Breeding, near the head of Camp branch of Rockhouse creek, is reported nearly as thick. This appears not unlikely, as seen at the outcrop. Westward, in Knott county, the place of this bed is marked by the outcroppings of cannel coal toward the top of the ridges. It is shown in the extreme northeastern corner of the county, in Section 5, as a forty-five inch splint coal. Analyses of samples of coal representing this bed, general table, (*l*) and (*m*). In Pike county this bed is best represented by the Dorton branch, the Bear Fork and Marrs' cannel coals. (Sections 10, 12, and 14). (See also Plate VII, A.) It is quite probable that the upper coal on Stone Coal creek, or Coal Run, below Pikeville Section 4), represents this bed. It will be seen from the map (see figures indicating locality of sections by number) that this bed covers a large area on the head-waters of the Kentucky and Big Sandy rivers. The Bear fork region promises well as a cannel coal district.

In the Robinson creek region another cannel horizon is found (Sec. 11 and 12, Plate III,) at the base of a coarse sandstone ledge, and but a little above an outcrop of indurated clay, which accompanies a thin coal. Little is known of this seam in Pike county beyond the fact of its presence, as indicated by tailings, and it is too high in the series to be found in Floyd, except on the left fork of Beaver creek and on Big Mud creek. It appears to

VIEW AT THE MOUTH OF ELKHORN CREEK.

be represented on Sycamore creek in the Elkhorn valley in Sections 15 and 16 by the lower of the two thin coals near the top. So far as known, no considerable importance attaches to this horizon in this part of the Pound Gap region. In Letcher county, however, it appears to be represented by Kiser's six feet coal. (Section 24, analysis [n.]) In Knott county it is represented by the twenty-six inch coal near the top of section 6, plate II.

In Letcher and Knott counties, sixty to eighty-five feet above the previously described bed, is a coal-seam which is interesting, so far as known, only as an illustration of frequent alternations in the conditions of deposits. Sections 6 and 24, with enlarged section Plate VII, A., give the details of this bed. About 200 feet higher up, and limited to a few hill-tops because of its high place in the series, a thick coal bed 80 inches, including a 4-inch parting, is found in the border of Knott county. (Sec. 27.) A 24-inch coal was opened about 50 feet below. Some of the ridges in Letcher are equally high, but the dip of the formation is such that they do not include this bed. The limestone beds, Sections 26 and 27, illustrate this point. In Pike county this seam is opened on Sycamore creek, showing 92 inches of coal. (Sec. 16.) There is a large area in the flat woods region for this coal. This table-land rises much higher above the drainage than the other hills along the belt adjacent to, and on the northwest side of Pine Mt. It also exceeds all other portions of this belt in the height of the geological section presented, by something more than 400 feet. This interesting feature makes the relation of the sections north and south of Pine Mt. more intelligible by showing that the great disproportion generally, in the thickness of the coal measures above the conglomerate, as represented on the two sides of the mountain, is caused by unequal erosion. (See sections in report of Mr. Thruston on the Poor Fk. region in Harlan county.) About 300 feet above the 92-inch coal last mentioned, on the shoulder of the Flat woods table-land, another thick coal occurs. The thickness is not known. It is reported in a well, 10 feet thick. It shows as a prominent stain in the soil, with abundant fragments of coal at a point where once partially opened. Its place in the series corresponds in general with one of the thick coals in the upper portion of the Harlan section. The hill here is about 150 feet higher, rising in a narrow ridge above the table-land.

Gathering the data at hand into a provisional general section, gives the following interesting exhibit of the vertical distribution of workable beds of coal in the Pound Gap region:

Top of highest hills in Pike county N. of Pine Mt.

150 to 175 feet covered slope.

Flat woods coal. Reported as a thick bed.

300 feet, more or less, mostly coarse massive sandrock.

Ambergys 80-inch coal. Sycamore Cr. 92-inch coal. (Highest workable seam in Knott county.

50 feet shale and sandstone.

Thin coal. (Sec. 27.)

25 to 40 feet sandrock and shale. (Highest rocks in Letcher county north of Pine Mt.)

Fossil and bastard limestone horizon. (20 feet shale.)

150 feet coarse sandrock, with shale divisions, forming benches.

Coal with many partings.

60 to 85 feet, mostly coarse massive sandrock.

Kisers 6-feet coal. (Letcher) Bear Fk. cannel, (Pike.)

150 to 175 feet, mostly sandrock.

Upper splint coal, 36 to 80 inches.

100 to 130 feet shale, shaly sandstone and sandstone.

Lower splint coal, 36 to 60 inches.

125 to 150 feet, mostly sandstone.

Thin coal so far as known.

15 to 40 feet, shales and sandstone.

Elkhorn coal, 40 to 108 inches.

20 to 40 feet, shales mostly.

Wright's coal, (Sec. 9, 17 and 22,) 12 to 42 inches (analysis (a).)

50 to 75 feet, shales mostly.

Sand Lick coal (No. 1,) 36 to 60 inches.

25 feet, sandstone and shale.

Combs' coal, (Sec. 20, 23 and 26,) 12 to 36 inches.

300 to 400 feet, shale and sandstone, the latter prominent in

places. Several thin coals; irregular but probably locally workable.

2,000 feet conglomerate formation, divided by shale beds of greater or less thickness into five to seven benches. Including several thin coals.

General Table of Analyses of Coals.

	Spec. gr. . .	Moisture . .	Vol. Comb. Matter. .	Fixed Carb.	Ash . . .	Sulphur . .
(*a*) Bear Fork, 32 inch coal	1.310	1 60	30.80	62 80	4.80	0.555
(*b*) Head of Camp br., 45 inches	1.317	1.26	30.00	52 70	5.74	2.752
(*c*) Gillam's cr., upper 31 inches	1.279	2.20	36.10	58.10	3.60	0.651
(*d*) Gillam's cr., lower 31 inches	1.293	2.40	35.40	58.26	3.94	0.692
(*e*) Head of Little Chloe cr., lower 56 in.	1.273	1.40	33.66	58.60	6.34	0.825
(*f*) Marian Hale Trace br., splint. 44 in.	. . .	1.30	38.10	58.40	2.20	0.710
(*g*) Wolf-pen cr., upper 34 inches . . .	1.385	5 46	31.68	57.46	5.40	0.488
(*h*) Wolf-pen cr., cannel, lower 26 in. .	. . .	0.26	47.94	44.86	6.94	0.751
(*i*) Mouth of Sassafras cr., 54 in. . . .	1.305	1.30	34.70	56.10	7.90	0.437
(*k*) Bentley's cannel coal	1.305	1.90	39.32	51.88	6.90	1.115
(*l*) Bear Fork cannel coal, 33 inches . .	1.293	2.00	43.40	46.30	8.30	0.689
(*m*) Nickel's splint coal, 46 inches . . .	1.320	1.34	34 16	56.70	7 80	1 318
(*n*) Kiser's 6-foot coal at out-crop*. . .	1.483	6.66	31.00	46.94	15.40	0.488
(*o*) Hager's cannel coal, Little Paint cr., Johnson co., 36 inch.	1.227	1.80	49.18	41.92	7.15	0.802

* In this coal the ash is probably doubled by adhering clay.

NOTE.—Columns cut out to represent the whole thickness of coal-beds were obtained for the World's Exposition, at New Orleans, from the following beds: Martin's coal (No. 1); Right Beaver, at mouth of Steele creek, Floyd county; Flemings creek coal (Elkhorn), Floyd county; Elkhorn coal, Elkhorn creek, Pike county; Elkhorn coal, Potter's Fork of Kentucky river, Letcher county; King's creek block-coal, Letcher county (see report of Mr. Hodge); Wolf-pen cannel coal, Knott county; Ambergys, 80 inch coal, Knott county; Hager's cannel coal, Little Paint creek, Floyd county; Wheeler's coal (No. 1), below mouth of Big Paint creek, Johnson county (see report on Morgan, Johnson, etc.).

GEOLOGICAL SURVEY OF KENTUCKY.

J. R. PROCTER, DIRECTOR.

PRELIMINARY REPORT

—ON THE—

GEOLOGY

—OF PARTS OF—

LETCHER, HARLAN, LESLIE, PERRY,

—AND—

BREATHITT COUNTIES.

J.
BY ~~A~~. M. HODGE, ASSISTANT.

STEREOTYPED FOR THE SURVEY BY JOHN D. WOODS, PUBLIC PRINTER AND BINDER, FRANKFORT, KY.

Profile Section of the Pine, Black and Cumberland Mts. (Diagramatic)
Dip greatly exagerated.

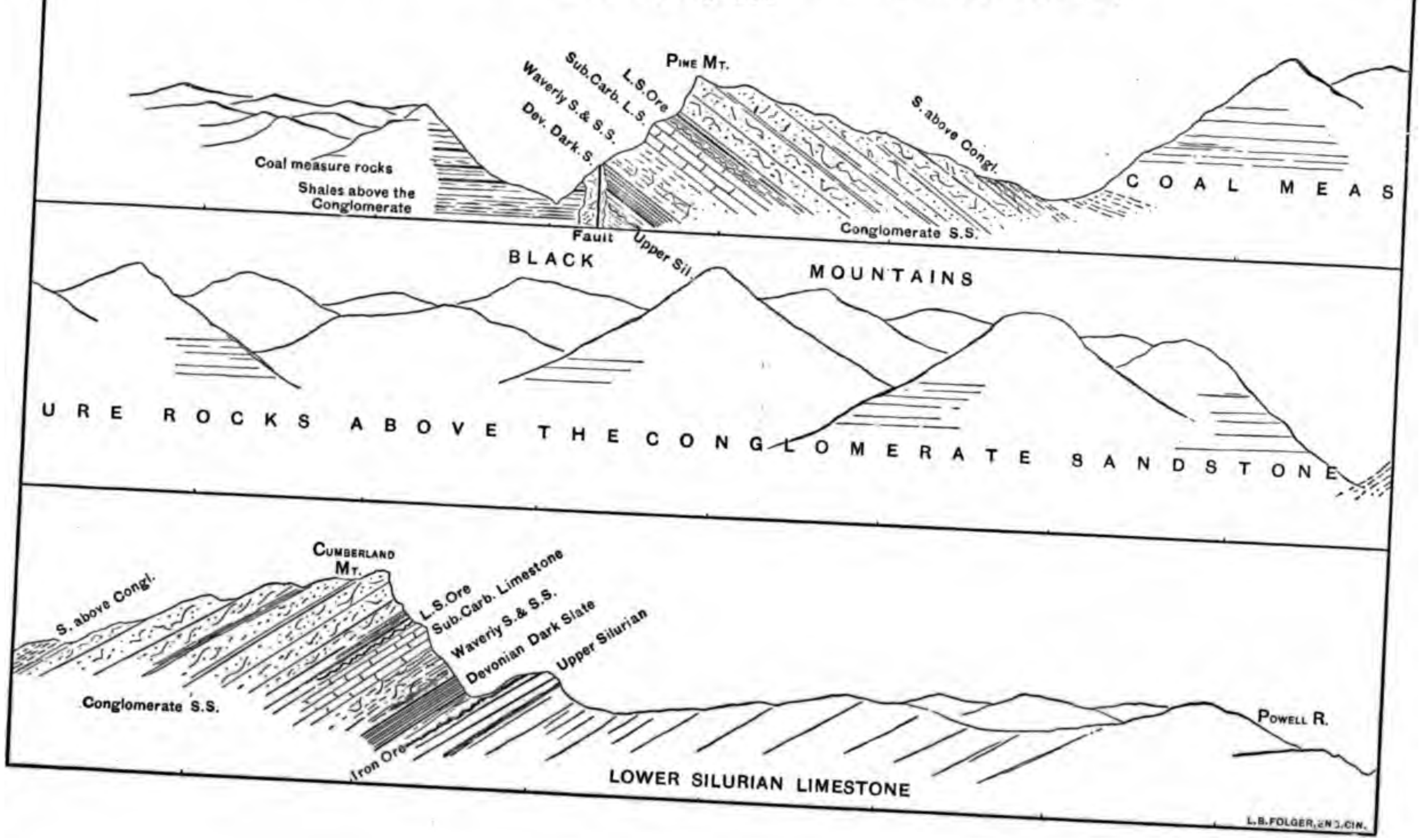
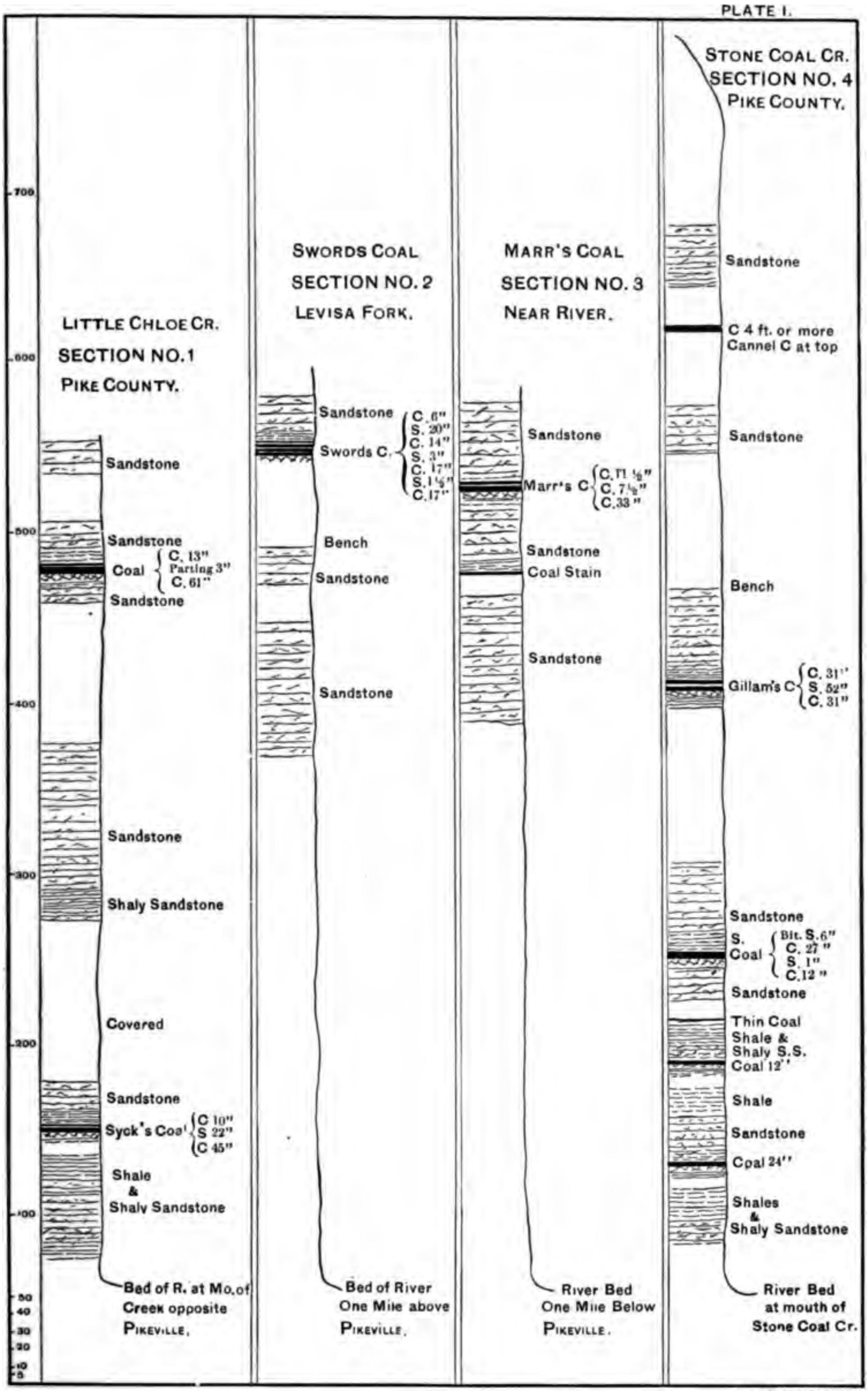
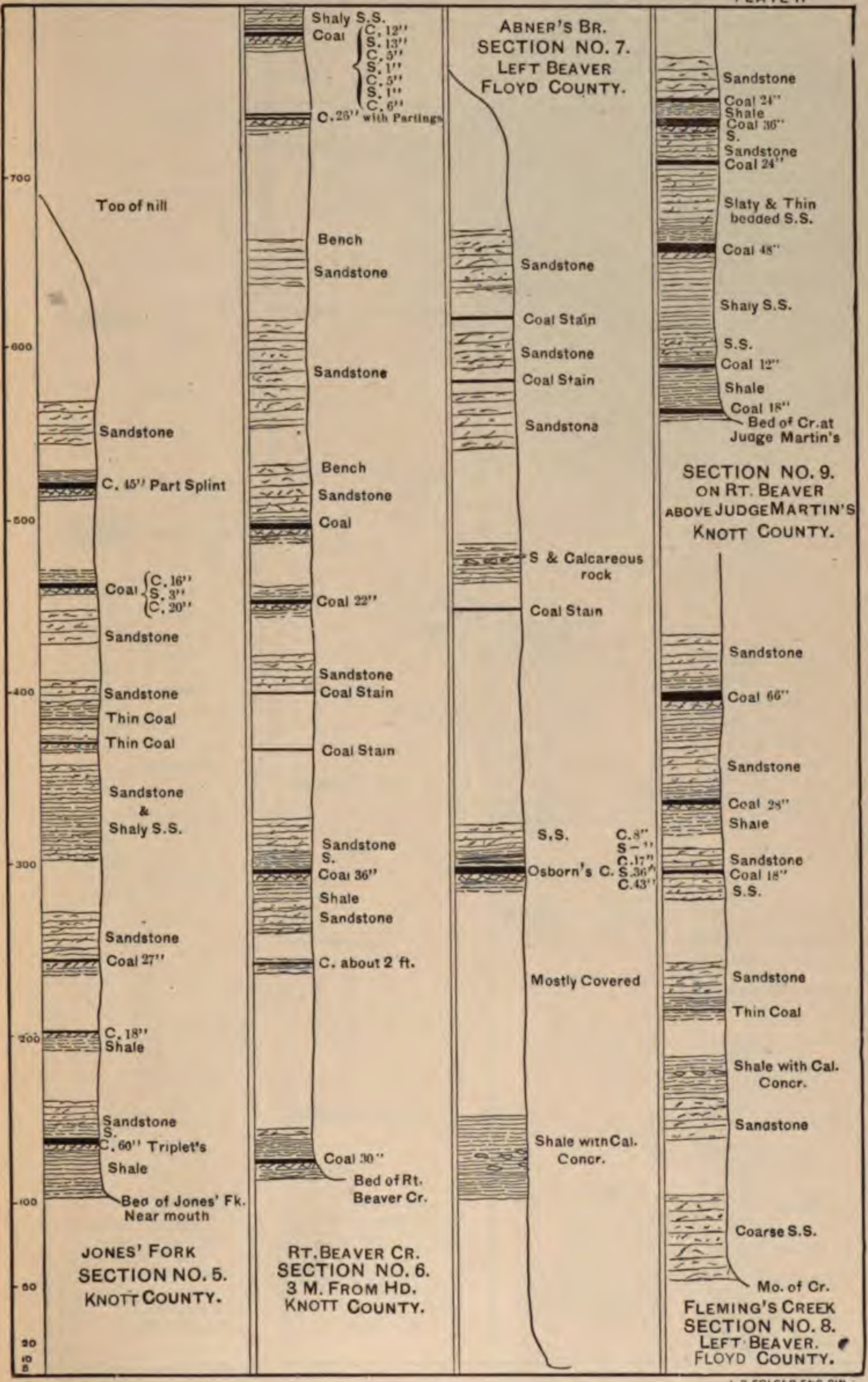


PLATE I.



L.B.FOLGER ENG.CIN.

PLATE II


JONES' FORK
SECTION NO. 5.
KNOTT COUNTY.

RT. BEAVER CR.
SECTION NO. 6.
3 M. FROM HD.
KNOTT COUNTY.

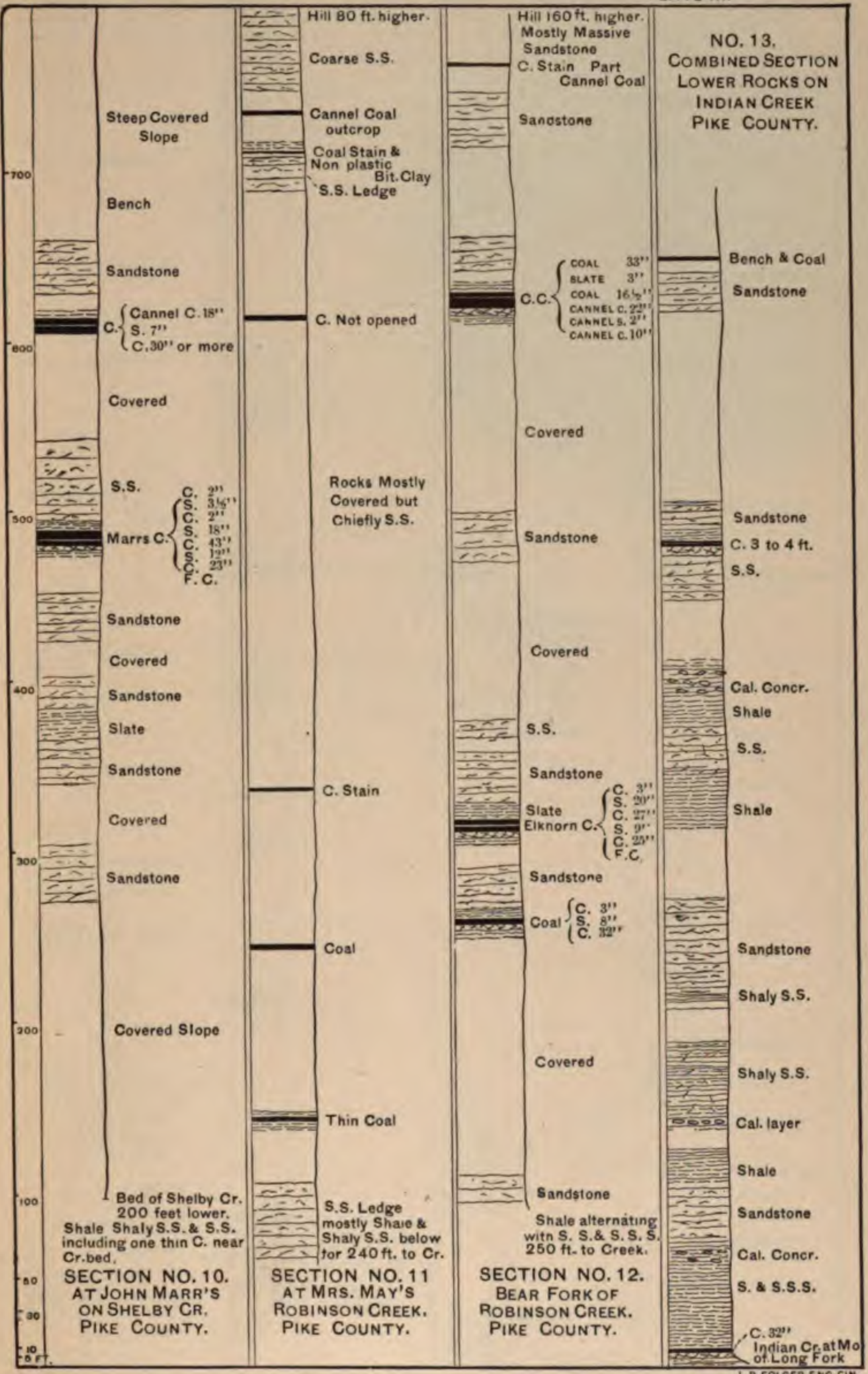
ABNER'S BR.
SECTION NO. 7.
LEFT BEAVER
FLOYD COUNTY.

FLEMING'S CREEK
SECTION NO. 8.
LEFT BEAVER.
FLOYD COUNTY.

SECTION NO. 9.
ON RT. BEAVER
ABOVE JUDGE MARTIN'S
KNOTT COUNTY.

L. B. FOLGER ENG. CIN.

PLATE III.



SECTION NO. 10.
AT JOHN MARR'S
ON SHELBY CR.
PIKE COUNTY.

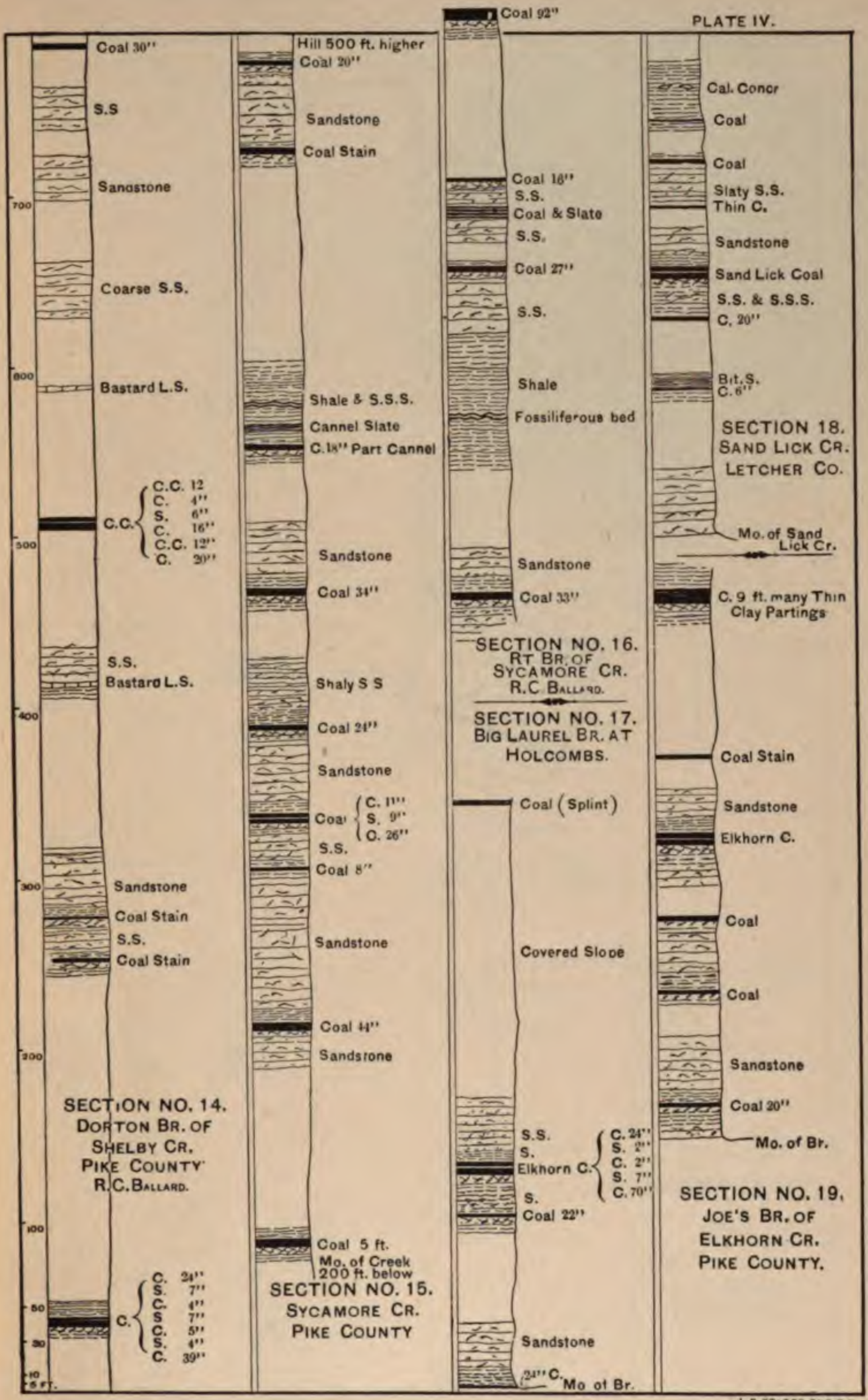
SECTION NO. 11
AT MRS. MAY'S
ROBINSON CREEK.
PIKE COUNTY.

SECTION NO. 12.
BEAR FORK OF
ROBINSON CREEK.
PIKE COUNTY.

NO. 13.
COMBINED SECTION
LOWER ROCKS ON
INDIAN CREEK
PIKE COUNTY.

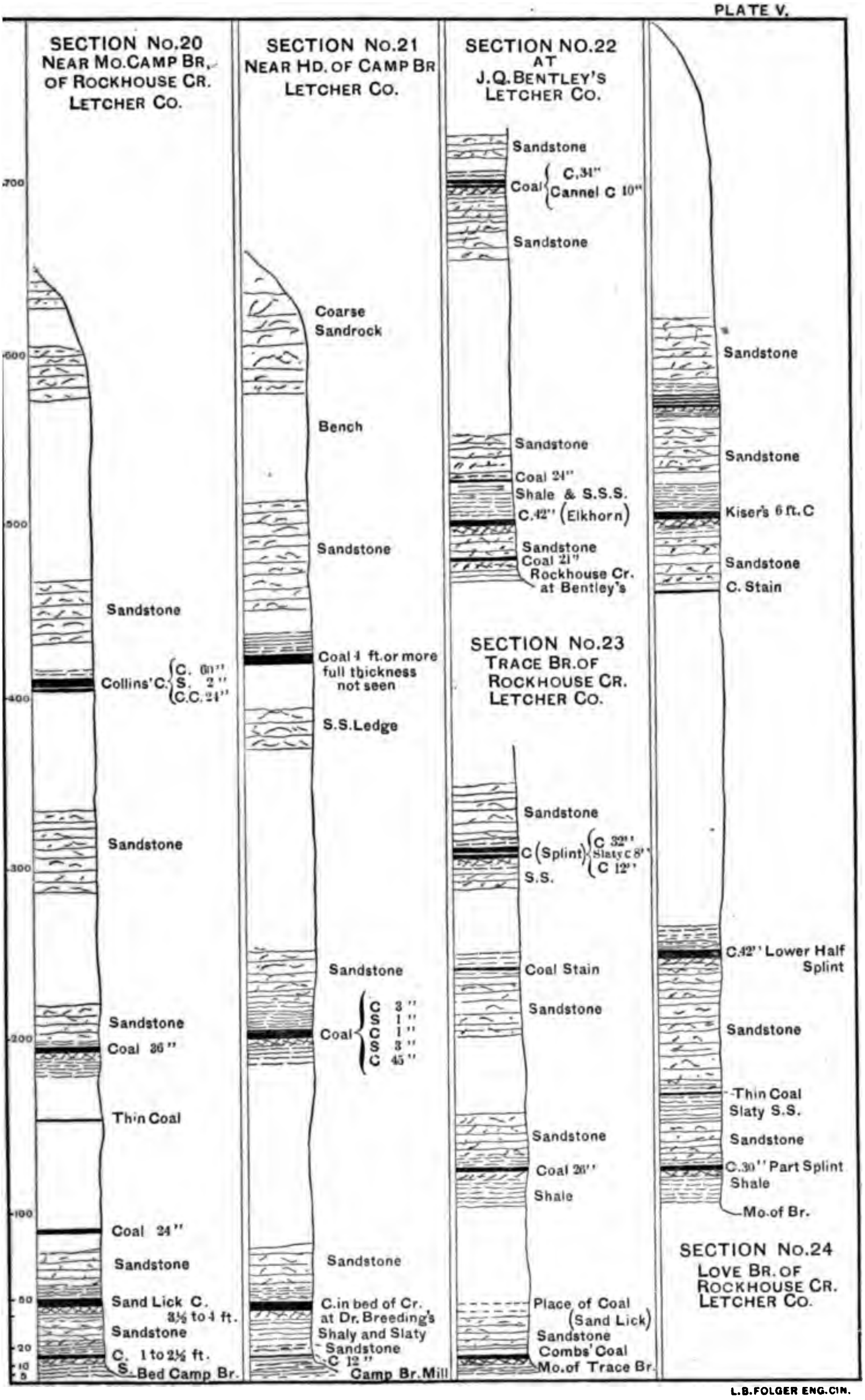
L.B.FOLGER ENG.CIN.

PLATE IV.



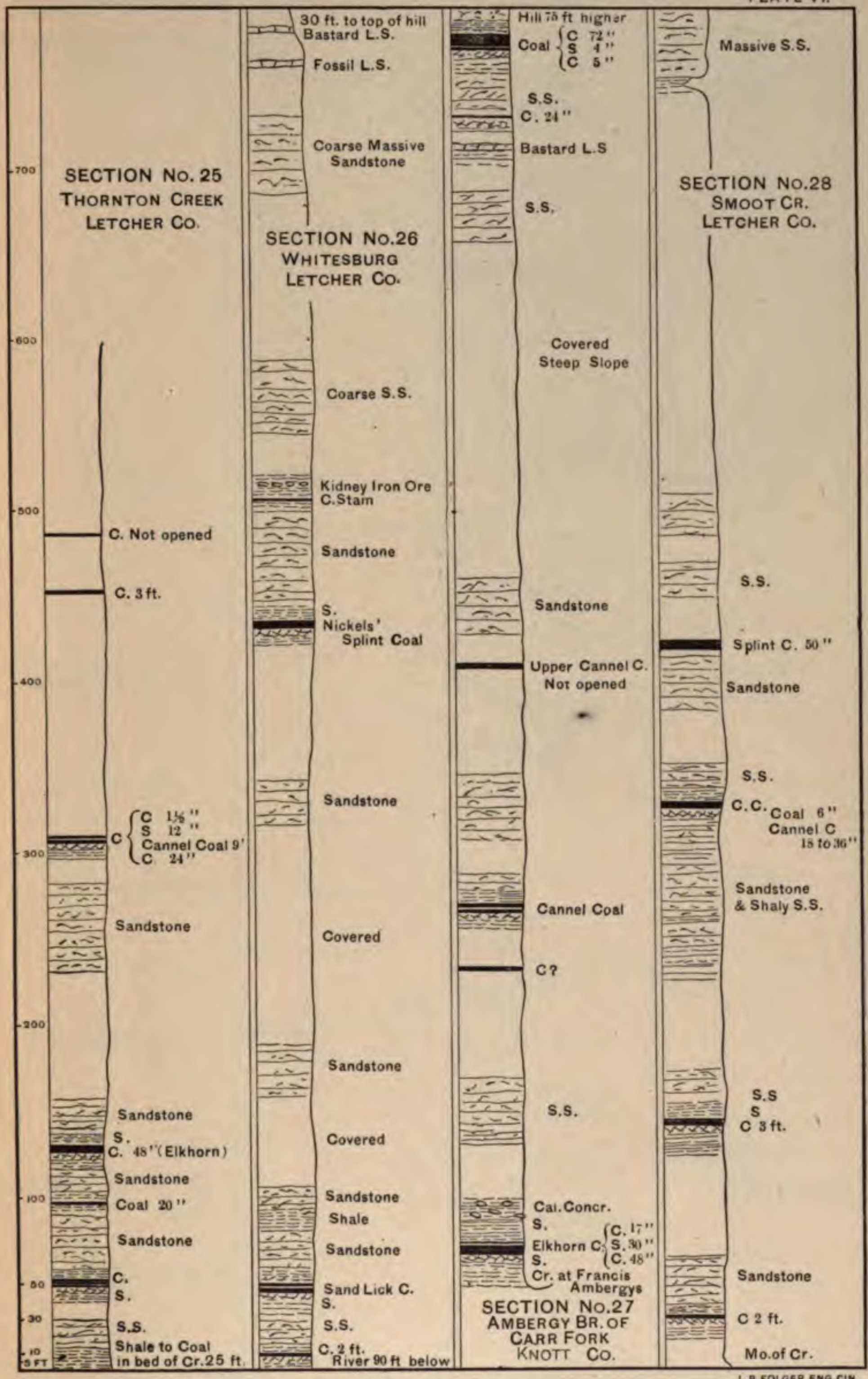
L.B.FOLGER ENG.CIN

PLATE V.



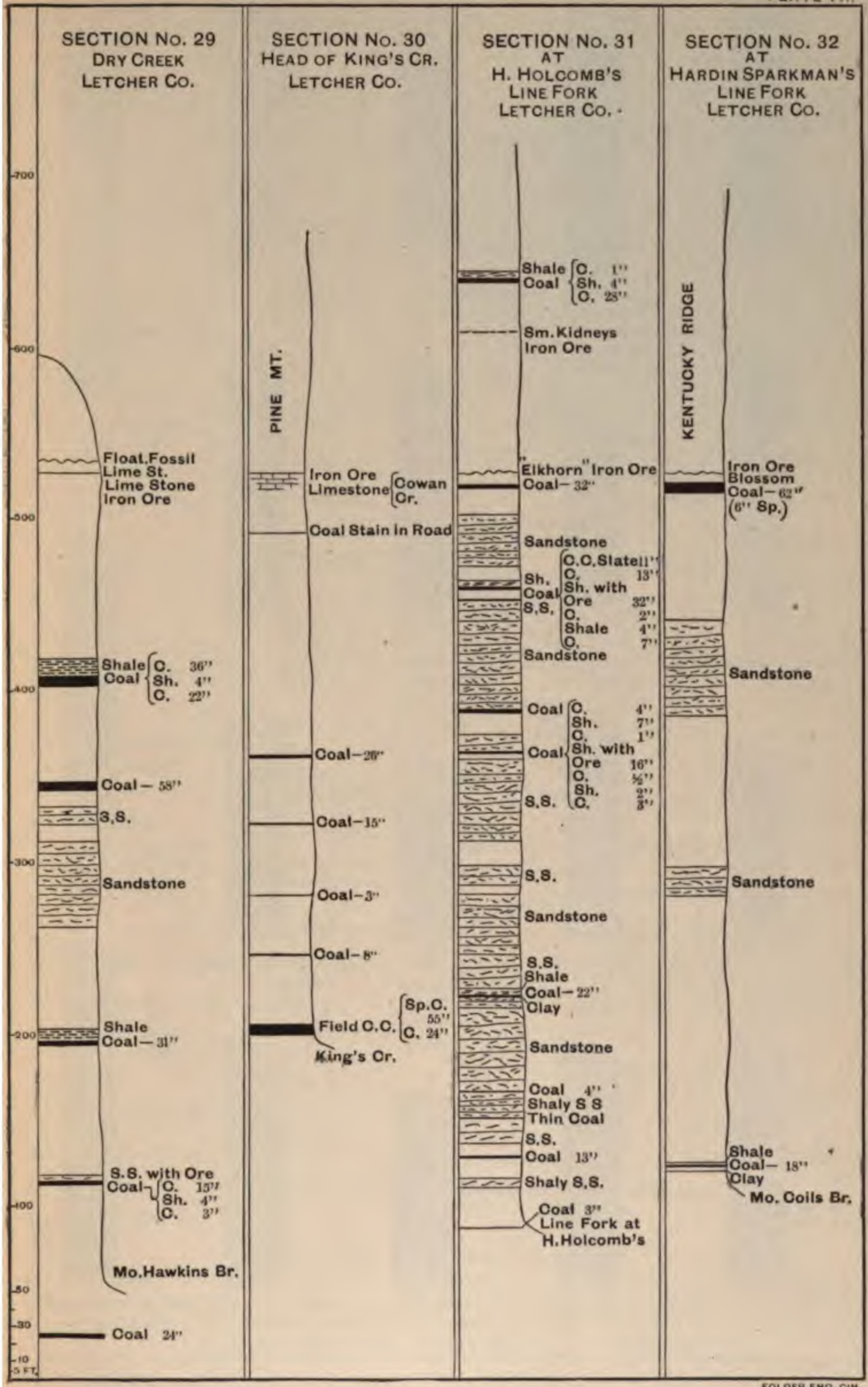
L.B.FOLGER ENG.CIN.

PLATE VI.



L.B. FOLGER ENG. CIN.

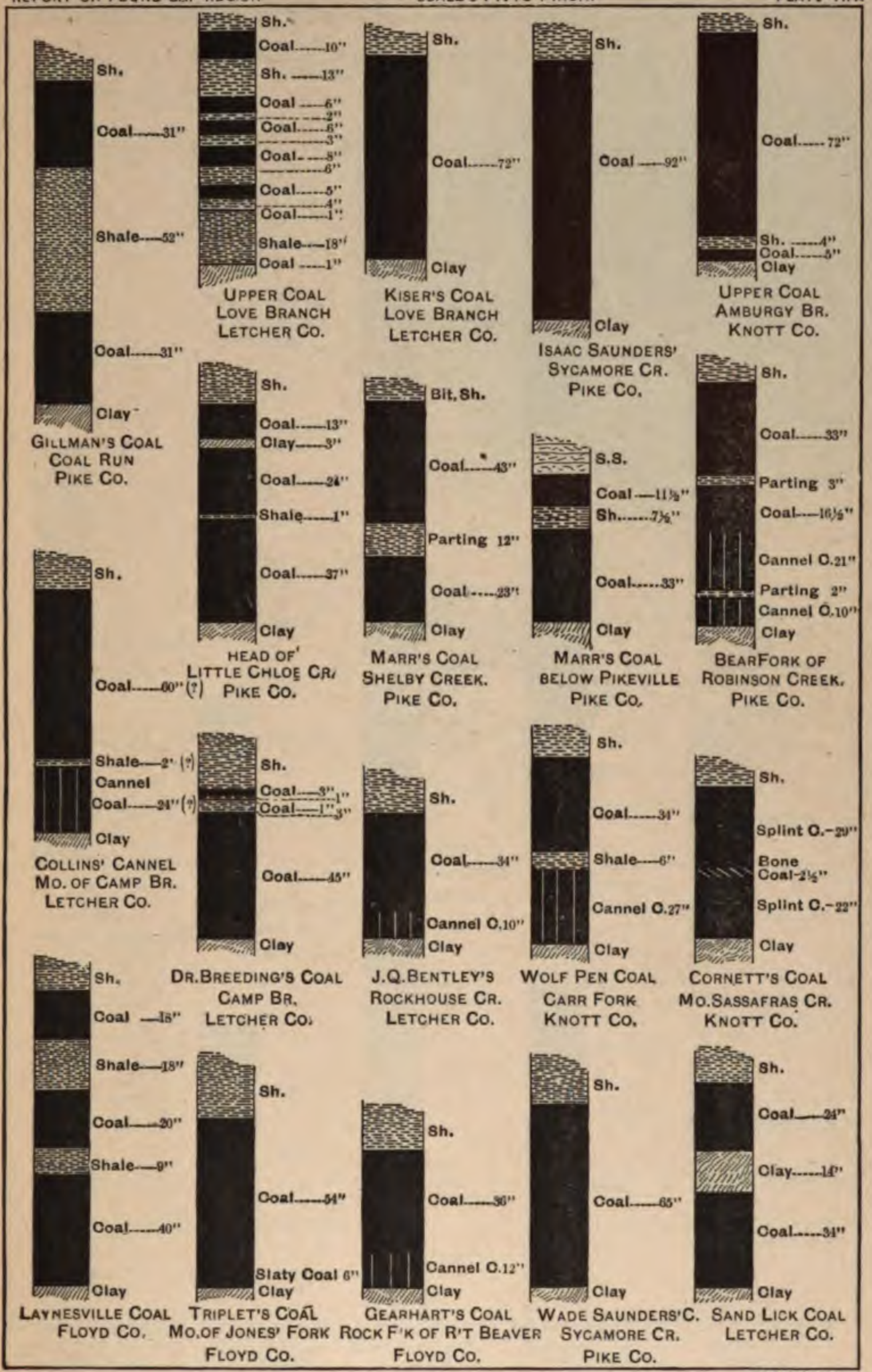
PLATE VII.



FOLGER ENG. CIN.

SCALE 5 FT. TO 1 INCH.

PLATE VII A



GILLMAN'S COAL
COAL RUN
PIKE CO.

COLLINS' CANNEL
MO. OF CAMP BR.
LETCHER CO.

LAYNESVILLE COAL
FLOYD CO.

UPPER COAL
LOVE BRANCH
LETCHER CO.

HEAD OF
LITTLE CHLOE CR.
PIKE CO.

DR. BREEDING'S COAL
CAMP BR.
LETCHER CO.

TRIPLET'S COAL
MO. OF JONES' FORK
FLOYD CO.

KISER'S COAL
LOVE BRANCH
LETCHER CO.

MARR'S COAL
SHELBY CREEK.
PIKE CO.

J.Q. BENTLEY'S
ROCKHOUSE CR.
LETCHER CO.

GEARHART'S COAL
ROCK F'K OF R'T BEAVER
FLOYD CO.

ISAAC SAUNDERS'
SYCAMORE CR.
PIKE CO.

MARR'S COAL
BELOW PIKEVILLE
PIKE CO.

WOLF PEN COAL
CARR FORK
KNOTT CO.

WADE SAUNDERS' C.
SYCAMORE CR.
PIKE CO.

UPPER COAL
AMBURGY BR.
KNOTT CO.

BEARFORK OF
ROBINSON CREEK.
PIKE CO.

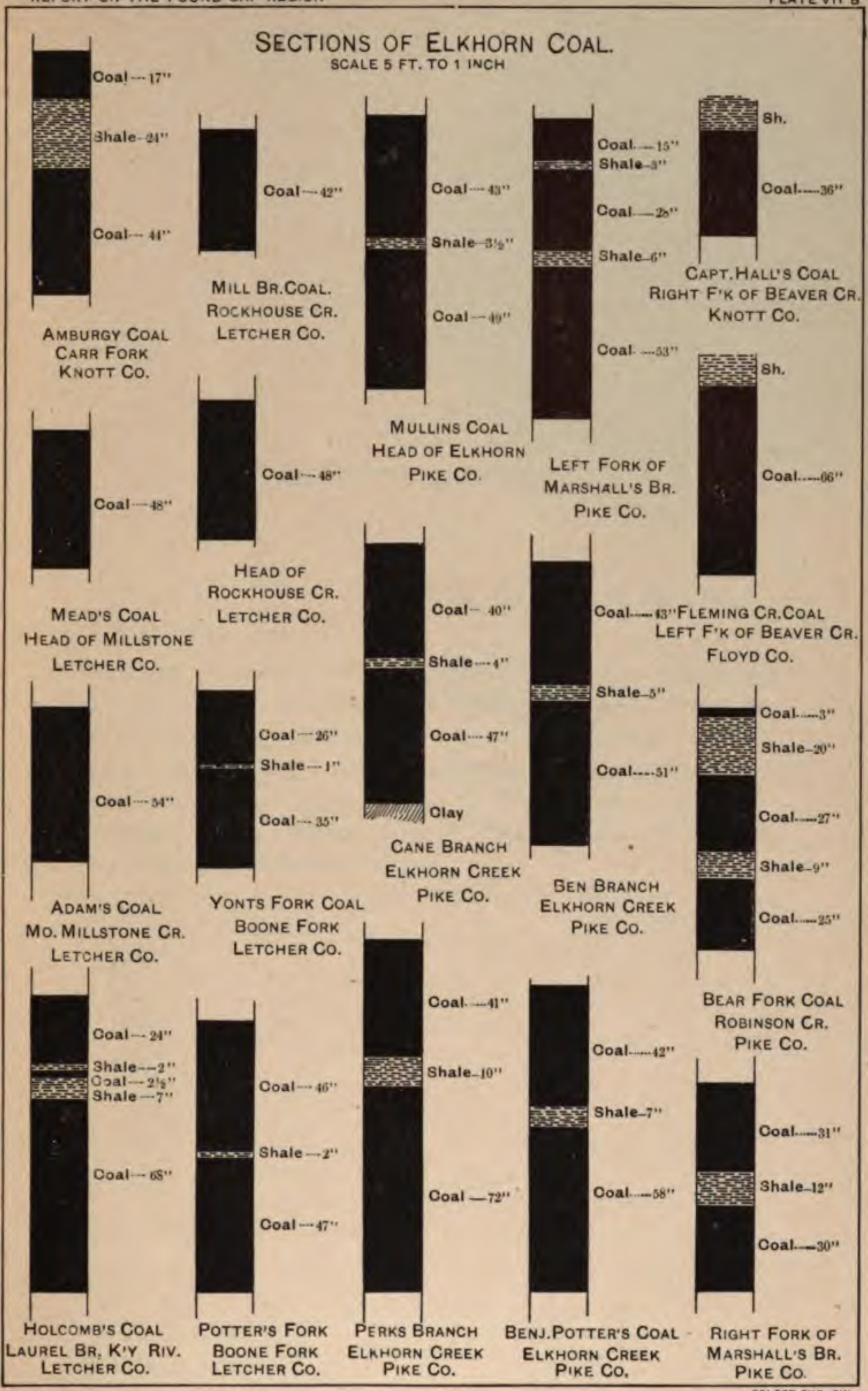
CORNETT'S COAL
MO. SASSAFRAS CR.
KNOTT CO.

SAND LICK COAL
LETCHER CO.

FOLGER ENG. CIN.

SECTIONS OF ELKHORN COAL.

SCALE 5 FT. TO 1 INCH



FOLGER ENG. CIN.

INTRODUCTORY LETTER.

LEXINGTON, KY., March 12, 1885.

Prof. A. R. Crandall:

DEAR SIR: I should feel that injustice had been done the region treated of in the accompanying report, were it not regarded as essentially preliminary. Some of the main requirements for a satisfactory knowledge of the field are indicated in the report, and many others will be found during a more thorough survey. That additional work is justifiable, and, indeed necessary, the report makes evident.

Respectfully,

J. M. HODGE.

PRELIMINARY REPORT ON THE GEOLOGY OF PARTS OF LETCHER, HARLAN, LESLIE, PERRY AND BREATHITT COUNTIES

A rapid survey, made over a considerable area, in continuation of the work of Prof. Crandall on the headwaters of the Kentucky river, where well defined marks of persistent beds are rare, has proven insufficient to carry the identification of strata to any great degree of detail. Enough work has been done, however, to trace the more important coal beds with a fair approach to certainty, wherever they appear of workable thickness. But it should be understood that, in this report, assumption of identity established is based frequently on what from personal observation is believed, but not known to be reliable evidence, and which is, therefore, still open to revision.

The region covered by the survey includes that part of Letcher county, lying north of Whitesburg, and between the west fork of Kentucky river and Pine mountain; the head of Greasy creek in Harlan county; in Leslie county, Cutshin creek to the mouth of Wooten; in Perry county, Leatherwood creek, the North fork to the mouth of Big creek, Lots' creek, Lost and Troublesome creeks; and in Breathitt county, Troublesome, Lost and Big creeks. Excepting Buckhorn creek and Ball's fork, the tributaries of the creeks named are generally included.

The strata are found to have a slight inclination, generally corresponding in direction with the course of the streams. They have their highest elevation against Pine mountain, about the head of Greasy creek, where, probably, the lowest coal above the conglomerate appears, dipping thence gradually down that stream and Line fork, but with somewhat more rapidity down Cutshin and Leatherwood creeks. On Line fork, from Pine mountain to Defeated creek, the strata lie nearly level, and an approximate line of strike appears to run, following the direction of Defeated creek, across to near the mouth of King's creek.

Northwest of this line an inclination is found sufficient to carry a coal bed lying 300 feet above Line fork at Isom's, down to 70 feet above the Kentucky river near the mouth of Lot's creek. The same coal bed is found at about the latter height above stream near the mouth of Wooten creek, on Cutshin, and again at the Tunnel mill on Troublesome creek. North and west from these points the dip is not quite so rapid as the fall of the main streams, which have a very gradual descent; the bed referred to above being about 100 feet above the river at the mouth of Troublesome creek.

If the coal beds have been correctly traced, there are partially developed, in this region, eight beds of workable thickness, of which number five are more or less frequently found as part cannel coal, but oftener as splint, and two others contain much splint coal. It is probable that some of these splint beds will be found valuable for coking, but no trials for determining this have yet been made. The table given on page 48 of analyses of samples collected from various openings, furnishes means of judging which are most likely to prove favorable in this regard. Particular attention is called to the admirable quality of the two samples of cannel coal included in the table.

A ninth bed to be described is the "Elkhorn" bed of Pike and other counties. Though some of the coal from this bed has been used near the mouth of Leatherwood and Troublesome creeks, in Perry and Breathitt counties, it is not classed here as a workable coal, and it derives its chief importance in this report from the fact that to the eastward it becomes one of the most valuable beds of the State. Other beds, too thin to work, appear and disappear throughout the strata with great irregularity, and are of so litle importance as to require no especial notice for a long time to come.

The lowest worthy of remark in the series, and one of the lowest beds of the coal measures above the conglomerate, appears above drainage in the region under consideration only on Greasy creek, Harlan county, and possibly on and near the Kentucky river, below Whitesburg. On the river it has not been found of workable thickness. On Greasy creek it has a thickness of 3½ feet, as shown in the lowest bed of section 42, at the only place where it has been opened. Further investigation is necessary to determine whether the deposit continues of sufficient thickness to render it of especial value. The outcrop extends up Greasy creek, probably to about the mouth of Big Laurel, and short distances up the branch streams below.

The coal appears from its surface opening of excellent quality, the greater part a high grade bituminous, possibly a coking coal. A peculiarity is to be remarked, found in the upper 16 inches of this, and in some of the higher coals on the heads of Greasy and Leatherwood creeks, consisting of the absence of all evidence of lamination, resulting in the formation of slikensides coal, a coal closely resembling anthracite in its cleavage, and somewhat in its lustre, but without the strength or hardness of the latter, and burning very freely with a bright yellow flame. An analysis of a specimen of this coal from the head of Leatherwood creek is given in the accompanying table. Its specific gravity and composition point to its being a partly formed cannel coal.

The next coal above in the series, partly a cannel coal, is most prominent, though perhaps not most valuable, on Greasy creek, where, on Half-Mile branch, Abner's branch, (section 42) it has a total thickness of coal of 7 feet, and of bed of nearly 13 feet, but its five partings materially injure it. Farther east on the main creek, these partings are so enlarged (section 41) as to form several distinct beds, which are still more separated on the heads of Leatherwood creek. A good workable seam is found there on Stony fork, a part of it being the soft "slickenseit" coal already described, and the remainder mostly an excellent hard splint. An analysis from an average sample taken from the whole bed, as shown in section 40, is given in the table of analyses.

On the main head of Leatherwood, as well as on Greasy creek, it is in part cannel coal, and it is probably the same seam which shows close to the bed of Leatherwood near the mouth of Clover fork, a splint coal of 32 inches or more, and again near the mouth of Owens' branch, 27 inches or more, with two thin partings, the two inches at the top being cannel coal. It drops below drainage not far from the latter place, and gives rise, probably in connection with another seam of the same bed, to the report of 12 feet of coal immediately below the surface of the ground, said to have been discovered in boring the salt well at the mouth of Leatherwood creek. Its outcropping as a thin bed on the river, a short distance above and below, as well as on Leatherwood creek, leads to the belief that the report is founded on a very small basis of fact.

On account of a local change of dip to nearly horizontal, one seam of the bed appears at Wm. McIntyre's (section 45) on the low water level of the river, two miles below Leatherwood, while six miles above the mouth of the creek (section 36) a part of the bed is 100 feet above the river there, and there again it contains a small seam of cannel coal. Farther east and to the south its separation into small seams precludes its specification, until, on Line fork, one seam disappears below drainage at John Holcomb's, while upper ones probably remain above as far as and beyond Hardin Sparkman's.

The third bed to be considered is the "Elkhorn" bed, previously referred to. Below Whitesburg, on and to the south of the river, it is thin and insignificant, until at the mouth of Leatherwood creek it attains a thickness of about two feet, with two or three partings. Its accessibility there led to its being mined a little for use at the salt well and neighboring houses. Followed up Leatherwood the partings increase, and on Greasy creek it seems to be merged in the bed below it. At Pennington's, on Cutshin creek, Leslie county, it is distinct again, but thin (the lowest bed of section 44), and its outcrop is exposed at several points on the road down to Wooten creek as a thin stain, at a nearly uniform height above Cutshin creek.

On the North fork, a mile above Hazard, its thickness is increased to 3 feet, (section 46), but it is so divided by partings, and apparently so impure, as to be without present value. It is lost beneath the river at the mouth of Lot's creek, but appears on Troublesome creek, where it has been traced some six miles up from the Tunnel mill, maintaining a height above the creek of about 15 feet, with a thickness varying from 1 foot to 2½ feet. Below the Tunnel mill it is represented by the thin seams shown at the bottom of section 49, and again is found thick enough to mine for local use at the mouth of Russell branch. Some coal has been taken also from the same bed in Lost creek, near its mouth, and from the river at the mouth of Troublesome creek, where two seams, 3 feet apart, are exposed at very low water, with a thickness of 20 and 12 inches. Followed up the river these seams rapidly separate to a distance of about 30 feet, and both appear above drainage on Big branch, together with a possible third seam, but whether a third seam, or the reappearance of the second at a higher elevation, has not been satisfactorily determined. In section 55 three seams are represented.

On Lost creek also a rise of strata has occurred similar to that near the mouth of Big branch, but of less marked degree, and the seams do not appear to be so separated there. Ten feet above the level of the mouth of Leatherwood branch of Lost creek, the bed shows but 15 inches of coal, with two thin partings, and again at the mill about two miles below the mouth of Ten-Mile creek, 17 inches of coal with four thin partings. At the mill-dam it disappears under the creek.

No samples for analyses of this coal have been collected from this region, but its quality does not appear to the eye to be so good in Perry county as in others where examined, those exposures which have been open to the air for a long time having become encrusted with a white coating, tasting strongly of alum. In Breathitt county this has not been observed, except in the upper seam on Big branch, the coal from the lower seam having an excellent reputation as fuel, both raw and coked.

Doubtless the most valuable bed of the series in this region is that which lies next above the "Elkhorn" bed, owing its importance not alone to its large area of good thickness, but also to its quality. As a bituminous coal it rarely shows other than an admirable quality, both by analyses and by its behavior in the grate, and this is equalled or surpassed where tested as a splint coal, which is its most prevalent character, while its frequent outcropping as an excellent cannel coal adds still more to its value.

From Whitesburg down the river to the mouth of Mace's creek, is a region practically barren in this as in other coals, it having a thickness at Wm. McIntyre's, below Leatherwood creek, of but 15 inches of coal, (section 45,) while at Allen

Christian's (section 36,) it is reduced to 5 inches. But to the south of the river (the region to the north being covered by report of Prof. Crandall) the thickness increases at Moses Isom's, on Line fork, to 25 inches, mostly cannel coal, and at Ira Hall's, on Defeated creek about two miles from the mouth, to 36 inches of handsome block cannel. On Dry fork of Line fork, its thickness diminishes again to 12 inches, 11 inches being cannel, while across the divide near the head of King's creek, it attains its maximum thickness, so far as known, of 78 inches, of which five feet is a block splint coal, which has been mistaken for cannel, and the remainder is bituminous. Unfortunately for this locality, however, it appears to be reduced to 25 inches a quarter-mile down the creek ; but there is abundant room for a large deposit of thick coal, with nothing to indicate an improbability of finding it under the hill to the south and east of the opening made.

Toward the head of Line fork it has been found only at Holcomb's with a thickness there of 22 inches. On Greasy creek it has not been identified positively, but it is most probably represented by the 55 inches of coal shown in section 41, the bottom coal being a slickenseit, the top splint coal and the whole of excellent quality. On Stony fork of Leatherwood it appears with 16 inches of cannel coal and 13 inches bituminous (section 40.)

On Cutshin creek it begins to show a more even thickness, with a better average. It is probably the bed which passes under the creek at the mouth of Laurel fork, bituminous coal, twenty-nine inches thick, increased at Levi Boggs' (section 43) to thirty-eight inches, of which all but six inches is cannel coal. At Isaac Pennington's (section 44) a further increase would obtain but that the lower eleven inches of the bed is there replaced by a bituminous slate, hardly to be distinguished from block cannel, and showing in its composition a near approach to cannel coal. An analysis of it is given on page 48, with those of the other coals. At J. C. Lewis', near the mouth of Wooten creek, the bed reaches a thickness of fifty-six inches splint and bituminous coal, with a fire-clay parting of five inches, and at Elijah Cornett's, on the river above Hazard, fifty-five to sixty inches of the same coal, with but one inch parting, and from there it has been mined and shipped down the river by boat. At Hazard the upper seam alone, thirty-three inches thick, is worked for the supply of the town.

In the bend of the river, a mile and more below the mouth of Lot's creek, a number of old openings, now fallen in, indicate a thickness ranging from three feet to five feet, and many other openings still farther down the river are reported, from all of which coal was shipped to Frankfort and other markets, until the recent opening of new railroads in the central part of the State provided cheaper and safer transportation from other fields.

On Lot's creek the bed is distinguished as containing twenty-two inches of particularly fine cannel coal, having by analysis but 6 per cent. of ash, with about the same thickness of bituminous coal. (Section 47.) On Troublesome creek it is thin again, but on Lost creek, first seen thirty-three inches thick near the mouth of Ten-mile creek, to the south of which it goes below the drainage. It is opened at G. W. Noble's, a half mile west of his house, thirty-four inches thick, and a mile south-east of the house, with the following section:

Bituminous Coal	22 inches.
Shale Parting	6 inches.
Cannel Coal	17 inches.

An analysis is given in the table of coal from the thirty-four inch opening.

An entry was made into this bed, near the mouth of Lost creek, by Judge Strong, and afterwards abandoned on account of water, in which was found only bituminous coal, although the bed crops out as cannel coal in an adjoining field. On Big branch (Breathitt county) it is represented by the fourth coal of section 55, and the cannel coal now mined and shipped down the river from George's branch, which has a reputation more than local, is probably from the same bed, as judged by the character of the coal and its known approximate geological position.

It is well to remark, as an indication of the value of this bed throughout a large part of the region embraced in this report, that on George's branch the only opening accessible and mined in the summer of 1884 had a section at its working face of:

Bituminous Coal	3 inches.
Splint Coal	17 inches.
Cannel Coal	17 inches.

Although the upper 20 inches is excellent coal of its kind, it was treated as waste, the cannel coal alone being able to bear the expense of two miles hauling by wagon and subsequent shipment at high water by boat, with its attendant risk of loss by wreckage. That a large and profitable development of these fields may be attained under the advantages derived by means of railroad transportation cannot be questioned.

From the foregoing notes of this bed, it is evident that a heavy body of coal exists, extending from Lost creek across the North fork, and between Cutshin and Lot's creeks to Carr's fork (beyond which reference should be made to Prof. Crandall's report), with rich pockets on Defeated and King's creeks, in Letcher county. Whether that on the head of Greasy creek is a part of a large area of thick coal or a small pocket remains to be determined. Its most important outcroppings as cannel coal are on Lost creek, 17 inches ; Lot's creek, 22 inches ; Cutshin creek, 32 inches ; on Line fork, 20 inches, and on Defeated creek 36 inches ; all but the latter being accompanied with bituminous or splint coal.

Lying from 15 to 50 feet above the bed last described is another one, generally bituminous or splint, but possibly containing cannel coal on Troublesome creek, above the Tunnel mill. Further investigation, however, may prove this to belong to the bed below. It appears to best advantage over the main body of the bed beneath it, and the two are in some places so close that the economy suggests itself of making there one connected mine in the two beds together.

Its greatest thickness discovered is at Pennington's, on Cutshin creek, 60 inches, excluding partings. At Boggs', further up the creek, it is reduced to 36 inches of coal. On Leatherwood creek section 39 it has 29 inches of coal, of which two-thirds is an exceedingly rich slickenseit, as shown by analysis on page 48. At Isom's on Line fork it is 36 inches thick. (The two openings of that thickness shown in section 34 having been made at points a considerable distance apart, though shown at different levels are considered as probably in the same bed.) At McIntyre's, section 45, the same thickness of coal was found, but it is there divided by three partings. On Lot's creek, 34 inches of very bright coal, has but one parting. On Lost creek it appears above drainage at Jacob Niece's, 26 inches thick, and retains this thickness at the mouth of Ten-mile branch. On Mill branch it is mined, on account of its proximity to the mill where it is used, with but 24 inches of coal, and that of poor quality. Further north it increases again to 36 inches on Big branch.

The next bed in order, seems to be quite as persistent as the others, but is, generally, too thin to be of much economic value. It is shown, the third bed from the top of section 31, as a thin coal, much separated by partings, and again on the Cutshin creek sections, 6 inches and 12 inches or more of coal. The 15 inches stain on Greasy creek (section 41) is probably of the same bed, and it is identified on Tolson creek and at McIntyre's below Leatherwood creek, at each place 9 inches of coal. On Lot's creek it is found only 2 inches thick, but suddenly reaches 60 inches on Comb's branch, Troublesome creek (section 48), entitling it to be classed as a workable coal. (For analysis, see the table on page 48.) The only other point where it has been found of considerable thickness is on Tom's branch, Troublesome creek, as represented in section 49.

On Lot's creek it has been traced as a thin coal, without evidence of any pocket there. On Russell branch, Troublesome creek, the rapidity of change of thickness which sometimes occurs is well displayed in this bed. At the spring by James Rholley's house it may be seen less than 1 inch thick, while it is exposed as a handsome splint coal, 22 inches thick, about 100 yards farther up the branch. Whether it continues to increase beyond there can only be determined by mining, as it very soon goes below the drainage.

The sixth bed in the series developed, neglecting undefined thin seams, lies generally about 60 feet from that below it. This is another one of the particularly valuable beds of the region, though its area of thick coal in this region seems to be confined mainly to two widely separated and not very extensive deposits. As a cannel coal it has won a high reputation in Central Kentucky, where it is known as the Haddix (incorrectly Haddock's) coal.

One of these bodies of thick coal is first encountered at the eastern margin on Line fork at Isom's, and again at Holcomb's, at both points having 32 inches of coal, but in the former separated by two partings. Farther west, on Turkey creek (section 33), an increase to 53 inches is exhibited, and at Sparkman's (section 32), to 62 inches without partings. Its appearance here and analysis (for which see table of analyses) are alike favorable to its being a coking coal. Its low percentage of ash is especially remarkable, because its outcrop opening was so soft and penetrated by mud that it was impossible to obtain a clean sample. The bed has not been identified on Greasy creek, but this is due to insufficient search rather than to its absence. A report of thick coal on Turkey fork of Big Laurel creek is supposed to apply to this bed, its approximate level corresponding with the Shepard opening across the divide on Oldhouse branch, where it is exposed, an excellent splint and bituminous coal, 70 inches thick. Farther down Leatherwood and on Cutshin creek, it has been found only as a thin bed, the upper one of section 44. On several branches of Lot's creek, openings have been made on what is presumed to be this bed, showing on the Dark fork 44 inches, and at various points on the Trace fork about 12 inches.

Sections 48 and 49, from Troublesome creek, show the bed but 10 and 18 inches thick, and the stain seen at Allen's, on Lost creek (section 50), was too unpromising to investigate. That at Niece's, farther down the creek, gives indications of a good thickness, with cannel coal reported in it, found in making a grave. On the North fork, near Big branch, where it has been opened by Gough & Co., to 50 feet underground, it was found about 4 feet thick at the entrance, diminished to 42 inches at the head of the entry. It is shown on section 55 as the Haddix coal, but in this entry it is bituminous and splint, while the mines across the river and about two miles below, from which the Haddix coal known in the market was taken, contained a large proportion of cannel coal.

The 58 inches of Russell coal (secton 56), and about 5 feet of coal, partly cannel, of the Robert's mine, near the mouth of Fugitt's branch, Troublesome creek, together with other thick outcroppings in the neighborhood, indicate the presence of a large body of coal in this vicinity, with a limit as yet undefined on the north and west. Its existence as cannel coal seems to be rather exceptional.

As the tops of the hills are approached identification of beds becomes more difficult, not only on account of a less extent of outcrop and tiresome ascent in getting to it, but also because the rain and spring waters there do not accumulate sufficient energy to wash out and expose the outcrop, and consequently, especially in this region where most of the land has been occupied but a short time, landholders frequently have not learned even of the existence of these beds, and search must be made without much help from them. This explains a marked reduction in the number of openings recorded of the remaining beds to be described. In the vicinity of Pine mountain their proximity to the limestone ores of that region was the means of establishing their identity.

The lower one of these upper beds, is separated, in the Troublesome creek region, from the bed last described by a massive sandstone, 100 feet thick, which appears in high perpendicular cliffs on nearly every hill, and not unfrequently forms their crests, making a marked feature of the landscape. South of Hazard this prominence of the rock is not observed, and against Pine mountain its character is changed by an admixture of shale, along with which was deposited the limestone ore referred to above.

The coal above the rock has a thickness of 42 inches on Smith branch, Leatherwood creek (section 40), is seen as a heavy stain on the main heads of Leatherwood and of Greasy creeks, and is exposed in a rockhouse at Cornett's, above Hazard, 31 inches thick (section 46). On Troublesome creek, near the Tunnel mill, it is 48 inches thick, and it has been found at Campbell's, about four miles below the mouth of Buckhorn creek, as a heavy stain lying 420 feet above the level of the creek and covered

At Rholley's, on Russell fork, it was discovered 62 inches thick, part splint coal, with two one-inch partings, as shown in section 56. And here it is necessary to state that the apparent increased thickness of strata of this section is to be attributed to their inclination as followed up Russell branch from its mouth to its head. A correct section would then represent the strata of about their ordinary thickness, or approximately as shown in section 55, in which the upper coals correspond with those of section 56. The 50 inch coal of Big branch belongs then to the bed under discussion, and also the 60 inches of coal of section 54, found on Leatherwood branch of Lost creek. Coal from these openings should be tested for its coking properties.

Comparing the thick coal openings of this bed with the one preceding, a remarkable coincidence is discovered. In both there is a heavy deposit about the heads of Line fork, Leatherwood and Greasy creeks, and again in both on Lower Troublesome creek and its vicinity, extending, however, in the upper bed to a greater distance south on Lost creek and south-east on Troublesome.

The remaining and probably uppermost bed of the region has been found, with two notable exceptions, of little estimation, but, being in part cannel coal and but little explored it is quite probable that some other valuable pockets, at least, may be discovered.

It is recognized as the top-hill cannel bed of section 33, on Turkey creek, and again as the 18 inches bituminous coal of the next section at Isom's, on Line fork. The cannel coal stain of section 38, from Beech fork, appears to have slipped from the bench above, where this coal should be in place, but nothing in the vicinity there indicates a thickness sufficient to induce further search for it. Across the ridge, and about two miles west from this place on Laurel fork of Cutshin creek, is a valuable deposit, which now must be considered as a part of this bed, though requiring determination. It is one of the exceptions alluded to above, and shows at Archibald Cornett's 67 inches of coal, of which 23 inches is a fine cannel, ranking by analysis among the first in the country. A section of the bed is shown in Plate XV. The upper bed of section 43, 25 inches bituminous coal found at Bogg' on Cutshin creek, is also referred to this bed.

Northward from the last named point many of the hills are not high enough to catch the bed, and it has not been identified, excepting in the eighteen-inch coal in the Lot's creek section, until near the mouth of Lost creek, where, on Mill branch, it again appears, but in a slip where its thickness could not readily be ascertained. It is a point where investigation should not be neglected. On Big Branch (section 55) an unfortunate point for opening the bed seems to have been selected, but eighteen inches of bituminous coal having been discovered, while at the mouth of Lost creek it was found thirty-six inches thick, and former openings in the vicinity, now covered by earth and water, are reported to have about three and a half feet of coal. Within 100 yards of the opening made on Big creek a line of cannel outcrop on the same level proves a sudden change in the character of the coal, and other hill-tops in the vicinity are reported as having an abundant outcropping of cannel, which may reasonably be referred to this bed, and which invites further investigation. The bed is known in the neighborhood as the Flag coal.

The thickest coal yet discovered in this bed in Breathitt county is at Rholley's, on Russell branch (section 56), where forty-five inches of splint coal gives it a decided value, which its height of some 500 feet above Troublesome creek does not diminish to the degree to be expected in this locality, as the greater altitude of the adjacent Flint ridge, compared with the surrounding hills, gives it an ample area for extensive mining.

In the following table are given analyses by Dr. Peter of coal from some of the principal openings which have been referred to. (Detailed sections of the beds at some of these openings are represented in Plates XIV and XV.) The analyses were made from samples taken where practicable from the whole working portion of the bed, excepting that of slickenseit coal, which was from a picked specimen. Inasmuch as most of the openings were not penetrated beyond the outcrop, the samples were frequently mixed to some extent with earth, and the proportion of ash resulting was correspondingly enlarged. Some allowance, therefore, should be made on this account, and to such as were probably most affected in this way an asterisk is affixed in the table to the percentage of ash given. The table is arranged in the order of the beds from the top down, and analyses from the same bed are connected by brackets.

LOCATION.	Total Thickness of Coal—Inches	Specific Gravity	Moisture	Volatile Combustible Matter	Fixed Carbon	Ash	Sulphur	Character of Coke.
A. Cornett, Laurel Fork, Leslie Co., top and bottom of bed	67	1.243	1.80	34.60	57.70	5.90	1.055	Spongy.
A. Cornett, Middle Bituminous portion	67	1.243	1.60	32.06	61.24	5.10	0.737	Spongy.
A. Cornett, 23 inches cannel	67	1.255	0.60	45.30	47.20	6.90	0.683	Dense.
J. Rholley, Russell Br., Breathitt Co.	62	1.426	4.20	32.40	52.26	11.14*	0.848	Dense.
E. Cornett, Kentucky R., Perry Co.	31	1.381	4.50	32.50	57.50	5.50	0.670	Pulverulent.
A. C. Russell, Russell Br., Breathitt Co.	58	1.345	3.80	35.60	54.80	5.80	0.875	Dense.
Gough & Co., Kentucky R., Breathitt Co.	42	1.362	1.74	34.06	53.80	10.40	1.808	Spongy.
F. Combs, Dark Fork, Perry Co.	44	1.570	5.20	31.86	52.94	10.00*	0.588	Pulverulent.
W. Shepard, Oldhouse Br. Perry Co. upper 18 in. not included	70	1.362	1.40	28.60	58.00	12.00*	0.958	Dense.
H. Sparkman, Line Fork, Letcher Co.	62	1.321	3.06	33.54	59.20	4.20	0.547	Dense.
H. Engle, Combs Br., Perry Co., two upper seams	60	1.356	3.00	32.80	56.14	8.06*	1.316	Pulverulent.
H. Engle, bottom of bed	60	1.338	1.50	31.56	56.54	10.40	0.849	Light Spongy.
Mill Mine, Mill Br., Breathitt Co.	24	1.366	1.40	35.90	52.50	10.20	3.483	Spongy.
Head of Leatherwood, Perry Co., Slikensides specimen	29	1.276	1.44	38.06	54.90	5.60	0.972	Dense.
G. W. Noble, Lost Cr., Breathitt Co.	33	1.363	1.40	33.90	51.90	12.86*	3.156	Spongy.
B. F. Grigsby, Lot's Cr., Perry Co., 22 inches cannel.	44	1.250	0.44	44.16	49.40	6.00	0.766	Dense Spongy.
Combs' Mine, Hazard, Perry Co.	33	1.287	1.50	33.50	61.20	3.80	0.794	Light Spongy.
J. C. Lewis, Cutshin Cr., Leslie Co.	56	1.319	2.00	31.00	59.94	7.06	0.665	Spongy.
I. Pennington, Cutshin Cr., Leslie Co., slate at bottom resembling cannel	33	1.595	2.20	26.14	32.06	39.60	0.519	Pulverulent.
Stony Fork of Leatherwood, Perry Co., lower seam	59	1.799	1.40	28.20	53.90	16.50*	0.978	Dense.
Half-Mile Br., Greasy Cr., Harlan Co., thickest three seams.	84	1.505	5.10	24.70	52.00	18.20*	0.725	Pulverulent.

Occasional outcroppings of iron ore have been found throughout the area explored, frequently of excellent quality, existing as kidney, block and limestone ore. While generally free from sand and rich in iron, the deposits of the two first-named varieties do not appear to be persistent, and are in too small quantities to merit especial attention. An exception may be made, however, for the ore on Turkey creek, Letcher county, shown in section 33, which bears too close a resemblance to the "little block" ore of the Hanging Rock district to be passed unnoticed.

The same paucity is noted in respect to limestone ore until within a few miles of Pine mountain, but throughout, wherever found, it is particularly rich in lime, and sometimes it is accompanied by limestone. As Pine mountain is approached the deposit of ore increases to a very considerable extent, being found most abundant on the headwaters of Leatherwood and Greasy creeks. As yet it has been looked for only as a means of identification of other beds, but, from the surface indications already seen, it is reasonable to suppose that a fair development will prove it to be of prominent value.

Limestone, so far as known, occurs throughout this region, as in counties northeast of it, only of little thickness in small areas in rather widely separated localities. It is believed, however, that in approaching Pine mountain a heavier and more generally spread deposit may be found lying immediately below the ore to which is given its name. Along Pine mountain the heavy outcrop of sub-conglomerate limestone forming its cliffs, continues as the result of its upheaval and the fault there. From this an unlimited supply of limestone may be drawn.

The bastard limestone boulders, common in the heavy shales of the lower coals above the conglomerate, are rarely met. In much of the region these beds are below drainage, and, where appearing above it, the place of the shales is generally occupied by sandstone. This is especially noticeable along the south side of the Kentucky river in Letcher county, a locality in which only very thin beds of coal occur. A comparison of sections taken there and in other localities, does not show this so prominently as does observation on the ground, where the character of the surface and loose rocks exposed often gives reason for conclusions as to the kind of covered strata beneath, when their actual positions can not be accurately defined on the sections.

A thin and very durable layer of flinty limestone, noted at various points north of Hazard and on Lot's and Troublesome creeks, is indicated in sections 48 and 49.

A remarkable deposit of flint, about 30 feet thick, lies on and near the top of Flint ridge, Breathitt county, a high dividing ridge between the tributaries of Troublesome and those of Quicksand creek on the north. From this bed fragments have been washed in great profusion down into the South Quicksand valley, and lie thickly strewn along the bed of the creek for several miles. Though of little economic value, the deposit is not without considerable geological interest, especially if it should prove to be of the same horizon as the black flint at the base of the "Barren Measures" of the Kanawha region of West Virginia, to which position it seems to be at least approximate. In color it varies from black through yellow to nearly white.

Approach to the high ridges separating the headwaters of Line fork, Greasy, Leatherwood and Cutshin creeks is rendered difficult by sandstone of a particularly hard and durable character, which, in many places, covers the ground so thickly with its detritus that wagon-roads have not yet been attempted over it, though probably soon to be made, and even bridle-paths are barely passible. Search for coal among these rocks is tedious and unpromising, though an occasional exposure indicates its presence. Cliffs, so generally associated with such rugged surfaces, are inconspicuous, or altogether wanting, probably for the reason that the streams, being small, do not have power enough to carry off the larger fragments, not easily disintegrated, which are broken from the mass and accumulate and protect it. The smaller stones are washed down and cover the stream-beds for miles below. Where this peculiarity exists, the rock is easily recognized, not only by the roughness of the ground it pervades, but also by the almost impenetrable growth of laurel, which accompanies it, invariably, it may be said.

It seems to be a feature of the locality, extending through the greater part of the measures represented there, rather than belonging to any particular geological horizon. Beginning above the second coal on Greasy creek, near the bottom of the series, and extending through nearly 300 feet of the measures on that creek, it is continued on the other three streams named from a higher horizon to an additional height of several hundred feet.

Reference has been made in the preceding pages to the salt-well at the mouth of Leatherwood creek, Perry county. Another one at the mouth of Troublesome creek is mentioned by P. N. Moore in his "Report on the Geology of a Section from near Campton, Wolfe County, to the Mouth of Troublesome Creek, Breathitt County." Neither of these wells were in operation in the summer of 1884, though the former was being re-opened at that time. No authentic information regarding them could be gathered at the wells, but it seems probable that the supply of salt obtained from them was unsatisfactory, and that they will be altogether abandoned when the present haul of about sixty miles is no longer necessary. These wells, and one on Goose creek, near Manchester, Clay county, which now supply a large area, indicate the presence of extensive saline beds.

In conclusion, the writer wishes to call attention to the fact that in the study of the coal measures, many supposed means of identification of beds, after closer investigation, are found to be illusive, and have to be abandoned. It still remains possible that further examinations may lead to a considerable alteration of his views regarding the continuity of the beds described. Especially may this be the case in the little explored extreme southern part of this region. But whatever changes in this respect may follow, the fact is established beyond dispute that there are large fields of coal throughout nearly the whole region, which are only awaiting means of transportation to become of great value.

Finally, he wishes to express his obligations, particularly to Judge E. C. Strong, at the mouth of Lost creek, for his aid in the examination of the coal-beds in that vicinity, and to all others by whom he has been assisted.

Analyses made by Prof. Thomas Egleston, of the School of Mines, Columbia College, New York, from Samples Collected by Himself. Published by Permission.

Below are given the analyses of all these coals, from the samples taken, just as they were found on the day they were taken. Some of them are somewhat higher in ash than those given by the Survey, but they show generally remarkably well, both as to ash and sulphur.

The following is a list of the places from which the samples were taken:

Sample No. 1. P. Duff's Bank, at Compton.
" " 2. Tyler's Bank, 2½ miles from Compton.
" " 3. Bed of the stream, near W. Day, on Frozen Creek.
" " 4. Myer's tract, opposite Jackson.
" " 5. Cannel Coal, Hargis Bank, mouth of Troublesome Creek.
" " 6. Bituminous Coal, Hargis Bank, mouth of Troublesome Creek.
" " 7. Upper part of Wolfe's Creek Bed.
" " 8. George's Bank, Cannel Coal.
" " 9. Lower part of Wolfe's Creek..
" " 10. Williams' Bank, Leatherwood Fork of South Fork.
" " 11. J. Clemmons' Lower Bank, S. Fork of Quicksand, Cannel Coal.
" " 12. J. Clemmons' Upper Bank, S. Fork of Quicksand, Cannel Coal.
" " 13. Limonite on J. Clemmons' Land.
" " 14. Combe's Bank, Main Quicksand, Rasp Cannel.
" " 15. Spencer's Bank, lower Spencer tract, Kentucky River, six miles below Jackson.
" " 16. Hobbs' Bank, Elkhorn Coal, 4½ miles from Compton.

ANALYSES OF THE COALS.

No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Nature	Bitum	Bitum	Bitum	Bitum	Can'el	Bitum	Bitum	Can'el	Bitum	Can'el	Bitum	Bitum	. . .	Can'el	S. bit.	Bitum
Water	5.35	5.36	2.41	. . .	2.78	5.27	4.88	1.54	1.60	0.35	2.81	2.30	. . .	2 44	5.64	6.13
Volatile combust.	36.68	38.78	47.02	36.98	48.22	38.00	36.83	45.43	48.72	66.28	39.43	45.60	. . .	44.26	37.72	37.54
Fixed carbon	50.94	53.25	43.76	50.60	44.24	52.02	51.41	40.14	47.59	29.73	48.22	47.12	. . .	43.48	49.37	53.08
Ash	7.03	2.61	6.81	9.37	4.76	4.71	6.88	12.89	2.09	3.64	9.54	4.98	. . .	9.82	7.27	3.25
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	. . .	100.00	100.00	100.00
Coke	57 97	55.86	50.57	59.97	49.00	56.73	58.29	53.03	49.68	33.37	57.76	52.10	. . .	53 30	56.64	56.33
Sulphur	3.19	1.00	3.78	3.32	0.78	0.84	0.75	1.74	0.75	0.83	1.24	1.71	. . .	1.21	0.99	0.77
Color of ash	Br'ish Gray.	S'dust Color.	Red'sh Brown	S'dust Color.	S'dust Color.	S'dust Color.	S'dust Color.	White	Light Brown	Light Brown	Gray.	Gray.	. . .	Whit. Brown	S'dust Color.	S'dust Color.

GEOLOGICAL SURVEY OF KENTUCKY.

JOHN R. PROCTER, DIRECTOR.

PRELIMINARY REPORT

ON THE

GEOLOGY OF THE LOWER NORTH FORK, MIDDLE AND SOUTH FORKS, KENTUCKY RIVER.

BY J. M. HODGE, ASSISTANT.

STEREOTYPED FOR THE SURVEY BY JOHN D. WOODS, PUBLIC PRINTER AND BINDER, FRANKFORT, KY.

INTRODUCTORY LETTER.

PROF. A. R. CRANDALL:

DEAR SIR: Herewith is transmitted to you my report on work done last year, covering a preliminary survey of what remained unexamined of the more important coal fields of the Three Forks of Kentucky river, with additional notes on parts of Wolfe, Breathitt, and Clay counties, where the work extended over territory touched in former explorations.

It is believed that enough work has now been done on these waters, excepting on Quicksand creek, to answer all present requirements, and to suffice until a final detailed survey becomes necessary. An exception should be made, also, in regard to the quality of the coal in its availability for coking.

Respectfully,

J. M. HODGE.

PRELIMINARY REPORT ON THE GEOLOGY OF THE LOWER NORTH FORK, MIDDLE AND SOUTH FORKS, KENTUCKY RIVER.

The work of which this report is a summary, consisted of an extension of the work reported upon last year, and embraced a preliminary survey of that part of the territory not included in those reports comprised in the water-shed of the North and Middle Forks, Kentucky river, down to Lee county (excepting the extreme eastern and western parts of Breathitt county), the western part of Wolfe county as far north as Red river, and the greater part of the South Fork, Kentucky river, water-shed above Owsley county.

Errors in the accompanying map of this region are due to the necessity of making it from inadequate data, much of which consisted of random notes taken in the saddle. Such additional material as could be found in the office of the Survey was also used, but it is remarkable that no map or notes of surveys could be procured which would aid in mapping Clay county, and none but a little detached work in Leslie county was available, excepting the maps of the whole State, on a small scale, and abounding in flagrant errors in their representation of this region.

Because of the lack of a satisfactory map, the one now presented is made to include a larger area, and is drawn in greater detail than is required for this report, in the hope that it may be useful for other purposes, until surveys are made from which may be drawn a correct map of this little known region.*

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* Leslie county has an area, roughly determined from this map, of 375 square miles; and of such roads as are passable for an ordinary freight wagon, there are barely 100 miles in the county, the travel being almost exclusively in the saddle or on foot.

A new arrangement of sections adopted is made possible by the certainty with which the lower splint bed is identified in most of them. This bed is, therefore, used as a base, and its elevation arbitrarily assumed at 500 feet in all of them. Where the location of this bed is not clearly ascertained the position of the section, relatively to the others, must be regarded only as suggestive of the probable place it should occupy, to be verified or proven in error when occasion requires. In the description following they are assumed to be in their right places.

The tracing of the beds having been carried down the North Fork, Kentucky river, to a connection with the lower coals and conglomerate again, a satisfactory check upon this work is established, and a return is made in the report to the system of numbering in use in the north-eastern part of the State.

Although the numbers given to some of the individual coal exposures may be, and probably are, incorrect, the main features are given with considerable more confidence than was felt in the report of last year, that work having been verified to some extent by the later work, and additional confirmation of both being gained by a comparison of this region with that of the north-eastern field.

The similarity existing between the two fields may be seen most readily by comparison of sections of the latter with the exhibit given on pages 98 and 99. The table given there is made up from the accompanying sections, and includes, with but few exceptions, all seams of coal shown in them, though where several seams appear to belong together in one bed, they have been so grouped at their average elevation.

A considerable irregularity will be noticed in the table, in the distances apart of the different beds. In western Breathitt, Wolfe and Clay counties this is mostly due to an actual difference of thickness of intervening rocks, while many minor differences throughout the whole region are to be attributed to unknown inclinations of beds between points of observation in the same section, and to variations of barometer due to changes of weather, which frequently occurred without opportunity for discovering and correcting them.

The table and sections probably do not give as favorable an impression of the coal region as it is entitled to, inasmuch as openings made in search of a bed are frequently abandoned on finding a single seam, when a more thorough search, for which time was not available, might have developed the main seam a few feet or even inches below the one found, and of much greater thickness. But so far as could be done this possibility was avoided.

The topography of a considerable part of the region to be described is determined by the position and character of the conglomerate rocks, and in part also by the composition of the rocks overlying them. About the head waters of the Middle Fork, Kentucky river, the hills are steep and high, and composed mostly of sandstone. Proceeding down stream a gradual reduction in height is noticed—with some exceptions—but the predominance of sandstone continues to about the point where the conglomerate makes its first appearance, and there a somewhat abrupt change of the greater part of the rock from sandstone to shale occurs, the hills are more rapidly reduced in height, and are more rounded in form.

On the North Fork this change to shale is very marked, and its line seems to lie close along the dividing ridge between Frozen and Holly creeks on the west, and Frozen creek and Red river tributaries on the north. Southwesterly the line can be followed from the shape of the hills across Breathitt county, and the corner of Owsley into Clay county, crossing Bullskin creek near its mouth; thence up Red Bird and Hector creeks, and to the Forks of Goose creek.

A rapid thinning of the measures accompanies the change in Breathitt and Wolfe counties, and where this is fairly accomplished the height of the hills on the conglomerate varies but little from one hundred and fifty feet. But down below the base of these hills the streams have cut their way in narrow, winding gorges through the conglomerate and strata below, sometimes to a depth of two hundred feet.

Most of the conglomerate of Clay county being easily disintegrated, these gorges are rarely found there, the slope being continuous with that above. But occasionally a more stubborn rock gives more or less of the cañon characteristic. Manchester, the county seat, is built on such rock, a part of it reaching a height above the creek of one hundred feet; but even there the slopes admit of streets upon them. Below the mouth of Little Goose creek it forms a cliff, "The Lovers' Leap," some seventy feet high, and at intervals on Little Goose creek and on Island and Laurel creeks lesser cliffs have been formed of the same rock.

The dip of the strata continues down the North Fork from Letcher county, slightly exceeding the fall of the stream, to a point near Fish-trap branch, where the "Elkhorn" coal is probably fifty feet below the river. But this refers only to the general inclination, for everywhere the strata lie irregularly in undulations of varied length and height. From Fish-trap branch on down the river a series of such waves are found, giving the strata an average slope, just about equal to that of the river bed, until the mouth of Stray branch is reached, two miles above Jackson, Breathitt county, where the "Elkhorn" coal is at the river level. From this point a continuous rise is observed, which, at the mouth of Bloody creek, Wolfe county, throws the same coal about three hundred feet above the river level. On either side of the North Fork the strata rise, as usual, towards the heads of the tributary streams.

The Middle Fork and its branches, as far down as the Leslie and Perry county line, follow synclinal axes in the same manner, but below that line the main dip of the strata is across the direction of the river and towards the North Fork. Its rate is undetermined, but a comparison of the sections on the two streams will give its approximate amount, as they differ little in their level at opposite points. On the South Fork such an additional rise has taken place as to bring the conglomerate to the surface through its whole length, probably. From the mouth of Red Bird, up Goose creek to Manchester, the rise is slight; thence to the forks of the creek a more rapid fall sinks the conglomerate below drainage, and from the forks south the rocks lie very nearly level.

The table of comparative elevations shows that there are in the region covered by it no less than sixteen coal beds, to which should be added one other to obtain the full number above the conglomerate. Of these beds, fourteen are of workable thickness, and one other, Coal 4*b*, will probably be found in pockets suitable for working when more thorough search is made. It is the bed described previously as below the upper splint bed, having some fine exposures on Troublesome creek, Perry county.

Of these seventeen beds eight are in part cannel coal, and openings have been made where the coal is thick enough for profitable working in all of these when suitable means of transportation are provided.

But two tests of the coal for its coking properties are known to have been made, and from them it is probable that two beds, at least, will furnish excellent coke. While it is quite possible that other beds may be worked for the same purpose, the greater part of the coal is not suitable for it.

Roughly speaking, the proportion of splint coal appears to grow less as the distance north and west from Pine mountain is increased, and also to diminish as the vertical distance from Coal 4, the lower splint bed, increases.

The additional number of beds over those reported a year ago is due mainly to a greater vertical range of rocks having been observed, and in part to the discovery of thick deposits of coal in beds previously seen in thin seams only, and not included in the former enumeration.

Where work of the two years joined, or overlapped, the later work has been confirmatory of the conclusions reached from the earlier, excepting that at the heads of Greasy and Leatherwood creeks, it is now believed, a less inclination and increase of thickness of strata obtains than was at first supposed, throwing the beds higher up in the stratigraphical scale. This will be referred to again in detail.

The accompanying sections have been numbered and arranged in order, as well as possible, to show continuously with last year's work, those farthest up stream coming first. For greater convenience in the description of the beds, an order somewhat the reverse will be adopted.

Coal 1.

This bed in Wolfe and Breathitt counties lies about ten feet above the conglomerate, as estimated by the writer, though put at twenty to fifty feet above it by Mr. P. N. Moore in his report, Part vi, vol. iv., p. 14.* The coal shows a nearly uniform thickness, where found at all, varying between two and three feet. The latter thickness is at its extreme south-western exposure, on the land of J. S. Hobbs, in a roll where it may be abnormally developed. Owing to the uniform character of the rocks over the conglomerate west of this point, and consequent easy slopes of the hills, its stain is rarely visible, and no other opening in it has been made in this part of the county.

It is reported that the Bear Pen coal, a part of this bed two miles south-west of Campton, was tested for coke, and, in confirmation of the opinion expressed in his report by Mr. Moore, excellent results are said to have been obtained. While there is no reason for doubting this, it is much to be regretted that time was not available for making a test, the results of which could be carefully and authoritatively specified.

The bed has been worked in various places about Campton, and also on Holly creek, where it is known as the "Branch" coal, from the fact that it appears in the beds of many of the small branches there. On main Holly creek it remains above the stream nearly to Mrs. Hollon's, some five miles from the mouth of the creek.

On Frozen creek it is exposed at several places on Mrs. Day's and the neighboring farms. Its stain is seen by the road on Little Frozen creek, and across the hill on the head of Cedar creek, and again at the mouth of Shockey Fork—in all these places with a thickness varying little from thirty inches.

Rising nearly with the main Frozen creek valley it should be found as far up as the mouth of Cope's fork, but above that it is believed to be cut off by a mound of conglomerate deposited above the level of the coal bed at the time of its formation. On Cope's fork no such irregularity appears, but the bed goes below drainage near its mouth.

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* This difference is attributed to an unequal allowance for pitch of the top of the conglomerate, or, perhaps, to a variance in opinion as to what is its top—a question often difficult to answer in this locality.

The rapid pitch of the strata up the river from the mouth of Frozen creek quickly carries the bed into the river. It is probably this bed which shows in the bank opposite Wm. Spencer's house, with only eight inches of coal and three inches parting, though possibly this should be referred to a thin seam above the main bed.

It has not been found elsewhere on the south side of the North Fork, and on the Middle Fork its only known exposure where it can be measured, at Isaac Terry's, on Turkey creek, gives but sixteen inches. Little search for it was made on the Middle Fork, as it is doubtless everywhere thin. It goes under the river somewhere near the mouth of Buck branch.

In Clay county the distance of the bed above the conglomerate is uncertain for want of any distinguishing feature in the top of that rock (the word conglomerate being applied to the formation and not to the constituents of the rock). About Manchester the formation is clearly evident, and at Gen. Garrard's mine the coal appears to lie directly on it, though some few feet of the sandstone underneath may be intervening rock. At the mouth of Bullskin creek the coal shows above forty feet of sandy shale, such as that of the western part of the county, which may, perhaps, be considered as a part of the conglomerate formation. On Laurel creek it is found close above the sandstone, and again, a mile away, with one hundred feet of shale below it.

The bed has been opened in many places in the county, with a somewhat better showing, generally, than in Wolfe and Breathitt counties.

At Mr. Davidson's, three and one-half miles up Bullskin creek, and about thirty feet above it, the coal is thirty-nine inches thick (see Plate XVIII); at the mouth of Little Bullskin creek, close to its bed, twenty-four inches without parting; and on both sides of the South Fork at the old salt works, Ammie P. O., about three feet, also without parting.

On Beech creek near its mouth it has been opened nearly three feet thick, but the coal was covered when visited, so that it could not be measured. Rising quite rapidly up Laurel creek, at J. L. Hornsby's, one mile up, it reaches its greatest known thickness of forty-five inches; and a mile farther up it is reduced to thirty inches. In other openings, beyond, the coal is said to be thicker again.

Several openings have been made in the bed in the close vicinity of Manchester, but they have been abandoned for thicker coal at a greater distance. At D. W. Roberts' opening, a mile up Horse creek, it is thirty-eight inches thick, and at the mine of Gen. Garrard, on the east side of Goose creek, thirty-one inches thick at the face, where a sample was obtained of which an analysis is given on page 97. Another mine of Gen. Garrard's, on the west side of the creek, is stated by Mr. C. J. Norwood, State Inspector of Mines, to vary in thickness of coal "from twelve to forty-two inches, with an average of thirty-two inches." This mine has been worked more extensively than any other above the Beattyville mines on either fork of the river. It is the only mine in Eastern Kentucky in which trouble from fire-damp has been experienced, and the evil there does not appear to have been great.

Above the forks of Goose creek the bed is below the drainage. On Hector creek the bed shows by the roadside in several places, increasing from six inches, some four miles up, to fifteen inches near the mouth; and near the mouth of Flat creek it shows about two feet of coal in the bed of Red Bird creek.

For a considerable part of Clay county this bed is the only one of value, and, though nowhere remarkably thick, it seems to run with sufficient uniformity to make a large area susceptible to profitable working.

It will be seen that the bed is below the drainage in the greater part of the region under discussion.

Coal 1*a*.

This bed has been noted at various points in Wolfe county as a cannel coal about four inches thick and thirty feet above Coal 1, in a heavy shale bank containing also many seams of small calcareous concretions. (At Wm. Burton's, on Upper Devil creek, eleven such seams were counted, none more than four or five inches thick.) Where the coal is thin it is a pure cannel; but it sometimes thickens to a large extent with such an increase of impurities that it remains worthless. Its most remarkable development is at B. T. Spencer's, four miles west of Campton, where it has been opened as cannel coal, but is nothing more than black slate three or four feet thick. Several attempts to work and burn it have been made near Campton, but all were unsuccessful. The bed is a convenience for determining the horizon of others in the county, but is without intrinsic value there.

In Breathitt county, on the North Fork, the bed seems to be wanting, and on the Middle Fork waters it has been recognized in but one place, at Isaac Terry's, Turkey creek, forty-five feet above the exposure of Coal 1, and it has there six inches of cannel coal on fourteen inches bituminous.

In Clay county the bed is generally thin or altogether absent. In sections 98, 99, and 100 it appears, the second bed from the bottom, the opening on Beech creek being the only one of especial note as a workable coal; it is shown in detail on Plate XVIII. It will be seen from its analysis given in the table, page 97, that the cannel coal here has an excessive proportion of ash. This results from including a little too great a thickness in the sample taken (and in the measurement of the cannel), the coal changing by hardly perceptible degrees from a good cannel to an unquestionable black slate. A few inches less of the dubious part taken would have given an analysis suitable for a good marketable coal.

Coal 2.

This bed, well known as a valuable cannel bed in more northern counties, has not been found as such on either fork of the Kentucky river. In Wolfe county it is a thin bed lying about sixty feet above Coal 1, generally in a heavy yellow shale.

At Samuel Napier's, a mile above Campton, it is twenty inches thick; at Wm. Burton's it has twenty-four inches of coal with two partings. This appears to be its maximum thickness in the county, and also in Breathitt county on the North Fork waters. It must go below the river near Jackson, but is above Quicksand creek from John Roark's to Hunting creek, probably.

On the Middle Fork it first assumes importance on Long's creek, near the mouth of which it has been opened about at high water-mark. Here it measures thirty-one inches of coal with a parting of four inches, identical with an exposure a half mile up Squabble creek, Perry county, excepting that the parting is there reduced to one inch.

A remarkably fine wagon-load of coal from an opening of Wm. Blanton's, one and one-half miles up Long's creek, supposed to be in the same bed, was seen by the writer, and a specimen obtained from it for the Frankfort cabinet. The coal is reported thirty-six inches thick, with six inches of parting additional, and its unusually fine appearance warranted an examination, but the opportunity was not afforded.

On Guy's creek, a mile from its mouth, the bed is exposed with but twenty-one inches of coal and two inches parting, underlaid by shale with small calcareous concretions. A covering of about eight feet of black slate extends over the bed from Long's creek to Rush creek. On the latter stream the coal has been worked a little, with a thickness of forty-four inches (Plate XVI), its handsome appearance probably more than compensating for the unusually large amount of sulphur in the upper seam, which its analysis, page 97, discloses.

On the river, a quarter of a mile above Elkhorn creek, it is opened thirty-five inches thick, at a height of seventy feet above the river, and at the mouth of Grassy branch its place is about at the river level. It is reported that coal has been taken from a thick bed in the river below Wilder branch.

Beyond this point it is well beneath the river to above Hyden, appearing again at Bowling's mill, with thirty-two inches of coal and two thin partings, and dropping finally beneath the river there.

In Clay county the distance of the bed from Coal 1 is increased to one hundred or one hundred and twenty-five feet. It appears at its best at the mine of Mrs. S. A. White's, on the Left Fork, Goose creek, where the coal was used quite extensively for evaporating brine. Near the mouth of the mine the coal measures forty inches, as shown in Plate XVIII; its analysis is given in the table, page 97.

An entry has been driven in the bed at Mr. Woods', a mile below the mouth of Martin's creek, with but about two feet of coal, and about the same amount is developed by several openings on Otter creek, near its mouth. Above this creek the bed soon goes below drainage.

On the right, or Collin's fork, Goose creek, it remains above drainage to near the head of the stream. It is the lowest coal of sections 103 and 104. At James Adams', a half mile below L. A. Byron's, it is thirty-three inches thick, exclusive of a parting of nine inches; and an opening at Isaac Swafford's, near the head of Buzzard creek, supposed to be in the same bed, has thirty-six inches of coal without parting.

In the sections 98, 99 and 100 the bed is shown with twenty-seven to twelve inches of coal, and nowhere in the north-eastern part of the county has it been found any thicker.

Without any definite guide in the matter, but from a general impression derived from passing through the western part of the county, it is presumed that the twenty-seven inches of coal at Wm. Wyatt's, near his house, on the Little Goose creek road, is in Coal 2. This bed is opened also on the head of Hogskin branch of a left fork of Sexton's creek, twenty-one inches thick; and probably also the same at Mrs. Reid's, at the head of Sexton's creek, thirty-one inches of coal.

Coal 3.

From the work that has now been done it is pretty well established that this bed is identical with the "Elkhorn" coal of the Pound Gap region.

In the south-western part of Wolfe county it lies about one hundred and fifty feet above the conglomerate, a distance increased to one hundred and eighty to two hundred feet at the mouth of Frozen creek, Breathitt county.

So far as his investigations carried him, Mr. Moore has accurately described the bed in his "Report on the Geology of a Section from near Campton, Wolfe County, to the Mouth of Troublesome Creek, Breathitt County," previously referred to, along which section it is a most valuable bed, as its many openings fully attest.

Some additional openings were made in Wolfe county for determining the extent of the thick "Hobbs" coal at the head of Upper Devil creek, and a test of the coking properties of that coal was made. The whole bed at the face of the "Hobbs'" entry, some thirty feet under ground, was measured as follows:

Coal	24″
Shale	7″
Coal	7″
Shale	2″
Coal	12″
Shale	11″
Bone Coal	1″
Coal (approximately)	17″

The lowest seam was measured in water, and was not included in the coking test, because of the difficulty of obtaining coal from it. The whole face had been submerged for a long time, and several days' work was required in order to obtain access to it.

The following analyses by Dr. Peter give the composition of the coal and of the coke made from it:

	COAL.		COKE.		
	A.	B.	*a.*	*b.*	*b′.*
Moisture	4.70	3.40	4.00	3.90	2.96
Volatile combustible matter	33.56	37.50	1.00	0.50	1.44
Fixed carbon	59.14	55.70	89.20	90.00	91.00
Ash	2.60	3.40	5.80	5.60	4.60
Sulphur	0.574	0.895	0.505	0.576	0.503

Columns "A" and "B" are from average samples of the upper seam of twenty-four inches and middle portion of nineteen inches respectively. Columns "*a*," "*b*," and "*b′*" are from selected specimens of the best coke obtained from the same respective divisions of the bed, the latter being from a portion of the splint coal which had not become thoroughly incorporated with the rest of the coke.

The coal is distinguished by a very low percentage of ash, and in the samples analyzed above, it shows rather less sulphur than was obtained from Mr. Moore's sample (see page 18 of his report), due, perhaps, to the long exposure of the later coal to water at the head of the entry. In appearance the coal varies little from the handsome specimens which may be obtained from the ordinary run of openings on the North and Middle Forks, Kentucky river, where the splint and common bituminous coals are interleaved, as is the case at this opening.

The process of coking was carried on in two hive-shaped stone ovens, built with an inside diameter of three feet, and height of about two and a half feet. A door was made at the bottom, by which the draft could be regulated, and an opening about eight inches square was left at the top. Ordinary clay mud was used for binding the stones together and closing all chinks, and when the ovens were finished earth was heaped about them, excepting at the door-way, half way to their tops.

They were then filled with coal from the two parts of the bed, kept separate, and the coal was burned for forty-eight and fifty-two hours. The result would have been more and probably wholly satisfactory had not inexperience led, through fear of overburning, to cutting off the draft soon after the fire was started. Nevertheless, in the centers of the masses of partly burned and somewhat smoked coke was found some that was sound and good, had a slightly metallic ring, and was fairly strong. Compared with the "Elkhorn" coke, as given by Professor Crandall in his "Report on the Pound Gap Region," page 21, this coke has rather the advantage in the matter of ash and of sulphur, and falls but little behind in fixed carbon.

The analysis "*b*'," from splint coal, goes to show that such coal makes a higher grade of coke, as far as its constituents determine it, than the common coking coal, but it has not sufficient tendency to agglutinate to make a satisfactory coke. Probably a judicious mixture of the two classes of coal would be most advantageous.

The promise of a large amount of coal held out by the "Hobbs" opening is not realized, as far as area of thick coal in that locality is concerned. Though a considerable amount may be won from the hill in which the main opening is made, no other such exhibit has been found. In an opening on the other side of the gap, less than a quarter mile away, the bed has the following section:

Coal	9″
Shale	2″
Coal	2″
Shale	8″
Coal	12″

Towards Campton it does not diminish as rapidly. At Wm. Tyler's, about a mile in that direction, its section is:

Coal	2″
Clay	13″
Coal	11″
Shale	2″
Coal	2″
Shale	2″
Coal	12″

It has been opened again on the same branch, above Tyler's house; but the opening was abandoned, and no other opening has been made in that direction. At A. M. Swango's, Stillwater creek, it shows a good stain, not opened.

Directly over the hill from the "Hobbs" opening, towards Holly creek, the bed appears to be cut out by sandstone, all excepting one seam six to eighteen inches thick. Near Poplar Gap, Upper Devil creek, on the land of J. M. Cockerham, it was opened with a section measuring

Coal	9″
Shale	4″
Coal	2″
Shale	7″
Coal	8″

with five inches of coal about ten feet above it. Various openings were made on the head of Hunting Fork, Holly creek, in search of it, but all were in thin coal which was not fully identified. At Jonathan Elkins', on Hunting Fork, the coal is probably eighteen inches thick. (Section 88.)

Of the many openings along the river from Bloody creek to Jackson, where the bed is known as the "River Hill" coal, all are now abandoned, pending improved means of transportation. From the report of Mr. Moore and information gathered on the ground, they run generally with from two and one-half to three and one-half feet of coal and a parting of from two to twelve inches. A new opening made in the course of this investigation at Mrs. Day's, near the mouth of Frozen creek, gave thirty-six inches of coal without parting.

But the impression first received from visiting these openings of a continuous body of thick coal is erroneous. In this bed, as in all others of the whole region covered by this report, and by that of last year under the same hand, no predictions can be made with any degree of certainty on the thickness of coal at any particular locality. But irregular as the deposits are, the sum of the areas of thick coal developed is enormous, beyond present calculation, and sufficient to warrant and repay large outlays carefully directed, but likely to lead to loss if full investigation follows, instead of precedes, the construction of extensive works.

Further, it should be remarked, that, in general, it has not been considered within the scope of this investigation to determine the bounds of thick coal in any particular locality, but rather to obtain a comprehensive view of a large area, and at the same time record all details as should come within the range of observation.

In the bed under discussion, an example of the uncertainty noted above is seen at A. C. Bowman's, on the river, two miles below Jackson. Here, on the south side of the river, an entry was driven a considerable distance into the hill before working coal was found; only the knowledge of its presence on the opposite side of the hill leading to persistent work. On the north side of the river the coal is exposed in a number of thin, irregular seams, in one of which a part of it is excellent cannel coal.

Above and below, on the river, the coal lies thick, while on either side, beyond those mentioned, such exposures as have been found are thin, or the bed is broken up into several widely separated seams.

Such is its condition on Big Pan Bowl branch, as shown by the lowest three seams of section 82, the Bowman cannel coal being there diminished to two inches; and a like separation exists where the bed has been found on the upper part of Frozen creek, though an approach of the seams is discovered on its main head. By J. R. Wilson's house two of them are ten feet apart, the lowest ones of section 86, and a mile above but three feet apart, and twenty-seven and seventeen inches thick without any parting. A mile further up the creek they are separated twelve feet, the upper seam with twenty-nine inches of coal having partings of two and twelve inches, the lower seam with the same thickness of coal and a parting one-half inch thick.

At G. W. Johnson's, Stillwater Fork, but one seam was found, twenty-seven inches thick.

About a mile up either fork of Cane creek, near the level of the streams, exposures of the bed exhibit the same variation, with a total thickness of twenty-one and thirty inches. On Stray branch the separation shown in the cliff at its mouth increases until the seams disappear beneath the creek.

On Quicksand creek, a half mile from its mouth, the bed, uncovered at low water, has twenty-five inches of coal and three thin partings; at John Roark's, three miles up the creek and eighty feet above it, the thickest seam has nineteen inches of coal (see section 81); from outcroppings on the creek, as far up as Hunting creek, no working coal is apparent.

From Quicksand creek to Troublesome the bed rises and falls along the bed of the river, and furnished without mining a considerable supply for local consumption; but it will not admit of extensive working there. Nor does it show to advantage in the region above up to Carr's Fork, Perry county, as developed in the report of last year, and further shown by its exposure in thin seams along the river between George's branch and Lot's creek. (See also the lowest coals of sections 80 and 79.)

On the waters of Middle Fork it is first recognized on Puncheon Camp creek, three miles from its mouth, one seam a foot thick. At Granville Spicer's, below Canoe Fork, are two seams, ten feet apart, with thirty-four inches of coal (section 76), and on Canoe Fork it shows about the same. So far as known to the writer, no exposure of the bed has been seen anywhere between Canoe Fork and Grassy branch, Perry county. It is quite possible that it may yet be found of good thickness, but the interest existent in that neighborhood when coal was marketed from there, quite as likely would have led to its discovery.

On Grassy branch and on Hell-for-Certain and Bull creeks, Leslie county, it is thin and broken up; but at the Asher entry, two miles below Hyden, it is massed almost into one seam with fifty-three inches of coal. (Plate XVIII.) Several openings have been made about Hyden and the coal found about three feet thick, the upper one of them, on Hurst branch, measuring:

Coal	27″
Shale	2″
Coal	8″

At John Bowling's the bed has but twenty-three inches of coal divided by four partings, but at Hughes Morgan's, or Saltwell branch, it reaches a thickness of fifty-nine inches of coal. (See Plate XVII and section 69, Plate XXII.)

The fifteen inches of coal at the bottom of section 68 is supposed to represent an upper seam of the bed, going underneath the Middle Fork near the mouth of White Oak branch. On Beech Fork it is probably not less than eighty feet below drainage, at the mouth of Oldhouse branch, but it rises again further up, to sink below finally about at the Harlan county line, with a thickness of but eighteen inches in the seam showing there.

Three miles up from its mouth, at Elias Howard's, on Greasy creek, the bed shows but thirty-one inches of coal, thirty feet above the level of the creek; at the mouth of Honey branch it is about sixty feet below drainage, and it probably continues at about that depth up to the mouth of Lewis branch, though at the mouth of Abner's branch it is thirty-five feet above the creek. It is the lowest coal of section 42 of last year's report, in which it is wrongly referred to a lower bed. Excepting this error, and also that the Coal

3*a*, now distinguished as a separate bed, is there sometimes included as an upper seam of the lower bed, the description of the "Elkhorn" coal, now determined to be Coal 3, is believed to be correct, and should be consulted for the region east of that now described.

In Clay county only a few openings have been made which can be referred to this bed, which here lies about two hundred and fifty feet above Coal 1. Sections 98 and 99, on Bullskin and Hector creeks, show a seam with seventeen and sixteen inches of coal. On Upper Double creek (section 96) there is but twelve inches. The bed shows at its best in the county at J. T. Smith's, Tom's branch, Red Bird creek, with thirty-five inches of coal; the lower five inches cannel coal. (See Plate XVIII, and section 102, Plate XXX, and for analyses page 97.)

On Collins' Fork, and perhaps for all the western part of the county, the distance of the bed from Coal 1 is probably somewhat less than given above. At L. A. Byron's (section 103) it has about three feet of coal cut up by partings. At Mrs. Hopper's, in Knox county (section 104), but twenty-two inches without parting, increased to twenty-six inches of very slaty cannel coal a quarter mile up Bull creek. At T. Jones', two miles up the same stream, the bed has the following section:

Cannel coal, inclined to splint	15″
Bituminous coal	1″ to 4″
Limestone concretions	3″ to 0″
Bituminous coal	7″

Coal 3*a*.

This bed varies in distance from Coal 3 from thirty-five feet on Hunting Fork, Holly creek, where alone it has been identified in Wolfe county, to one hundred and twenty feet on Collins' Fork, Goose creek, Clay county. Its usual distance is about sixty feet.

It is ordinarily a thin coal without value, but it has one pocket, at least, of excellent cannel coal, lying about eighty feet above Quicksand creek opposite and below John Roark's. Numerous openings have been made in this deposit, and considerable coal taken from it, but now they are all abandoned and generally covered up. At one of them the following measurements were obtained:

Bituminous coal	13″
Cannel coal	18″

a thickness somewhat less than has been given in other reports. It is stated that unsuccessful search for working coal has been made in the neighboring hills, and that the old workings are nearly exhausted.

The bed is identified back of John Roark's as the eleven inches of coal of section 81, and opposite Jackson (section 83) it is in two thin seams.

For other points in Breathitt, Perry and Leslie counties, it is sufficient to refer to the table of elevations, pages 98 and 99, as the bed is uniformly thin, excepting where split up into many seams as shown in section 70, the third bed from the bottom, and in the lowest bed of section 93; and also as found at Henry Chappell's, a quarter mile up Elk branch, Greasy creek, where thirty-seven inches of coal has four partings. It should be noted also that it occurs again as cannel coal at the mouth of White Oak branch, Middle Fork, Leslie county, and that where indicated as lying close to the bed above it, it might be, perhaps, correctly included as a lower seam of the upper bed, instead of assuming it to constitute a bed in itself.

In Clay county its presence is shown in various sections; but with a thickness rarely exceeding eight inches, it is only necessary for present purposes that the fact be stated.

Coal 4.

This bed, from previous investigation determined to be the chief one of a considerable part of the drainage area of the North and Middle Forks, continues to hold this distinction over much of the region now under consideration. Heretofore it has been designated on the above streams as the "lower splint" bed, and as Coal 4 it is most widely known as the Hunnewell cannel of Greenup county. In many other localities in North-eastern Kentucky the bed carries cannel coal, and though the same is not infrequently present in it in this newly explored region, it retains, throughout, its general character as a splint coal bed.

In Leslie county the bed is generally divided and strongly marked by a parting of non-plastic fire-clay from one inch to eight inches thick, a peculiarity extending into some of the adjoining counties, and even through Perry into Letcher county, and rendering the identification of the bed particularly easy and sure.

On account of this, and because it is rarely wanting in the sections made, this bed is taken as a base in grouping the sections in the plates, the scale of each plate of sections being placed to indicate this bed at an elevation of five hundred feet.

The bed in Wolfe county lies fifty to eighty feet above Coal 3, too high to be found in most of the hills south-west of Campton. At A. M. Swango's, on Stillwater creek, it is an excellent coal without parting and thirty-four inches thick. At Jonathan Elkins', on Hunting Fork, Holly creek, it has been opened in front of his house with about six feet of coal and shale, measuring in its upper part:

Coal	6″
Shale	5″
Coal	2″
Shale	3″
Coal	5″
Shale	15″

The lower part is said to have one thin parting and two good seams of coal, but it was covered so that it could not be measured. Below and back of his house two abandoned openings are reported as having twenty-seven and thirty-six inches of coal and a parting about two inches thick.*

Other exposures in the southern and western parts of the county, which have been identified, show the bed only with thin coal. It is found as cannel coal, seven inches thick, at the head of Red river on the Hunting creek road, and reports of other cannel outcrops between that and Campton are referred to this and the two beds next above.

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* The measurements of coals of section 88 are given as reported by Mr. Elkins, who has done considerable towards developing the coals in his neighborhood. He is confident that the above openings are in the "River Hill" or No. 3 Coal bed, on account of the resemblance of the coals, and because of their thickness and partings being similar to those of openings of the latter along the river. The writer's conclusions are based on the distance of the bed above the conglomerate (determined by the four inches of cannel, Coal 1*a*), on its distance from the outcrop near the top of the hill, which can hardly fail of being Coal 5, and on the number of intermediate beds.

On Frozen creek, Breathitt county, it is uniformly thin, and sometimes separated into several seams, only the twenty inches of good cannel coal at James Cope's, on Davis' branch, giving promise of a workable bed. On Cane creek, a mile from the Markham Branch Gap, it has twenty-one inches of coal and nine inches of shale in two partings. Near the head of Stray branch it is a splint and semi-cannel bed sixteen inches thick. Near the mouth of Markham branch it is opened under the name of "Coal Harbor" coal, thirty-five inches thick, with a parting of one inch.

Two miles above Markham branch the bed has increased to six or seven feet, in an old opening where it could not be measured, and from that point for two or three miles farther, on the north side of the river, it appears to hold to a thickness of thirty to thirty-six inches with some regularity. On the south side of the river it has been found only in thin seams, between Markham's and George's branches. On George's branch is the cannel coal (Plate XV) described in the report preceding this, now established almost with certainty as belonging to this bed.*

The numerous entries along the branch, and absence of any on adjacent branches, is indicative of a closely limited pocket of thick coal. An abundant outcrop of cannel coal is found, however, on the head of Lick branch nearest George's branch, and on Wolfe creek another enlargement of the bed has occurred. This is seen at openings about a mile from the river, where the coal reaches a thickness of eighty-eight inches without parting, the lowest twenty-seven inches closely resembling the curly cannel coal of the Haddix mines in a higher bed. An analysis of the whole thickness is given in the table, page 97. Such unusual thickness in this bed cannot be expected to hold through any great distance, and a considerable reduction is reported on either side of this main opening within one hundred yards. It is scarcely possible, however, that an ample quantity for working should not be found.

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*The somewhat singular statement is made of this coal, that all that is mined from the east side of the branch is so explosive that it can be marketed only with some difficulty, and at a lower price than that taken from the west side, which burns quietly and without flying from the grate.

Continuing up the North Fork no further knowledge of this bed is obtained until Caney creek is reached, near the mouth of which, at John Deacon's, was discovered forty-two inches of coal, the lowest nine inches being cannel coal (Plate XV), and this is probably not the full thickness of the bed, as the opening was made in the point of a hill down which the coal pitched and had wasted to some extent. Analyses of the two seams of the bed are given in the table.

Crossing the hill from Caney creek to the river above, the coal is found again at Cardwell's, probably somewhat under three feet thick, and again a mile up Grapevine creek, Perry county, at John Spencer's, where it is said to be three feet thick; but it was so covered that but twenty inches of coal could be seen. On Thomas Johnson's land, two miles up Ebersole branch, the bed is first found to contain the fire-clay parting previously alluded to, and having here a thickness of but one inch. The fifty-seven inches of coal opened, of which twenty inches is splint coal, is represented in Plate XVI, and its analysis is given in the table of analyses. A half mile down the branch it is opened fifty-five inches thick. Its development on this stream, taken in connection with that on Guy's creek, yet to be described, augurs exceedingly well for this locality.

As shown by its exposure a half mile up Henson's branch, the bed has changed its character very much in that distance, its section there being as follows:

Coal	4″
Shale	1″
Coal	16″
Fire-clay	4″
Coal	7″
Shale	1″
Coal	2″
Shale	2″
Black slate	5″
Cannel coal	9″
Black slate	7″

Near the mouth of Rock Lick branch are two exposures, nearly alike, in which the coal is concentrated again and is somewhat thicker than as given above. One of them is shown in Plate XVI, and an analysis of the coal is given in the table. (See also the lowest coal of section 78.)

Its next exposure, on Willard creek, near its mouth, has the following section:

Coal	2″
Fire-clay	4″
Coal	10″
Clay	4″
Coal	6″
Black slate	3″

At Samuel Whitaker's, near the head of the creek, the upper seam is entirely gone, and below the fire-clay is but one seam of coal fifteen inches thick.

Again the coal has increased to a good working thickness on the river four to five miles below Hazard. Among other entries, abandoned for the time, one of Alexander Combs' has thirty-seven inches of coal in sight, and it is said that a lower seam of the bed is present (under the fire-clay) which has not been worked; the other now partly covered openings indicate it. In more extensive mining there is no reason why both seams should not be made use of.

Points farther up the North Fork have been treated in the report preceding this, but to them may now be added the twenty-one inches of coal found on Big creek, and shown near the bottom of section 58; the fifty-seven inches of Woolrey Campbell's, on Mace's creek (Plate XVI), and the twenty-two inches coal of section 57.

On that part of Middle Fork and its tributaries in Breathitt county, the bed has not been found of workable thickness, its best exposure being at Crawford's on Beginning branch, where it occurs as a cannel coal eighteen inches thick. The analysis given in the table of a picked specimen of this coal shows it to be of rather ordinary quality. The specimen was selected, however, on account of a peculiar stain of iron peroxide, which banded one of the layers of cannel blocks, and not as representing the best of the coal.

Exposures on Puncheon Camp creek, Canoe Fork, and at Granville Spicer's (section 76) have only thin bituminous coal. At Turner's, on Lick branch (above Turner's creek), a promising stain was brought to the surface by a slip, under which the solid coal lies deeply hidden.

A quarter mile above the mouth of Squabble creek, in Perry county, the bed first appears as a workable coal. Its one opening belonging to Peter Gross, lying at a height of two hundred and eighty-five feet above the river, has thirty-six inches of coal without parting, measured at the face of the entry some twenty-five yards underground. This coal is of remarkably fine appearance: a dull black, hard and strong, and nearly uniform coal, a part of it almost without visible lines of lamination. By general report of the neighborhood it is the finest bituminous coal that has been sent down the Middle Fork, and it brought an advanced price in the market. Reason for this report is readily seen in its analysis (page 96), giving but 3.10 per cent. of ash, while in other respects it stands well up among good coals.

At the mouth of Guy's creek the fire-clay again appears in the bed, parting forty-eight inches of coal; and two miles up the creek a total thickness of forty-seven inches was measured, probably including fire-clay, though it was not noticed. That at the mouth of the creek was hard and black, scarcely distinguishable from coal, excepting on fracture. Taking these openings in connection with those on Ebersole branch, North Fork, their close resemblance almost justifies a prediction of constant working thickness nearly from one river to the other.

But farther up the Middle Fork, as on the North Fork, the bed becomes thin, sections 74 and 73 showing but eight and ten inches of coal; on Bull creek an increase to twenty-eight inches is noted, and about Hyden the bed has been found with only thick coal over a large area. This is represented by detailed sections as follows: Wm. Sisemore's coal, Rockhouse creek, Plate XVIII; John Lewis', on Hurst branch, J. C. Brewer's and Reuben Magyard's, Cutshin creek, on Plate XVI, to which should also be added J. C. Lewis' fifty-six inches of coal on Cutshin creek, and on Plate XVII, John Bowling's and Jesse Morgan's coals, on Middle Fork, and on Burnt Camp branch above Hyden. (For analyses, see the table, page 96.)

Near the head of Rockhouse creek the bed is reduced to twenty-four inches, that part of it under the fire-clay having wholly disappeared, and, though absent at one opening on Hal's Fork, Big creek, as shown in section 97, at two others near by it is present, but with a thickness of four inches only. At these two openings the seam over the fire-clay is fifty-three inches thick. (See Pleasant Sisemore coal, Plate XVIII.)

Above the mouth of Greasy creek, on Middle Fork, and on Beech Fork, the bed as yet found is too much cut up by partings to attain to the value it has below that creek. It appears probable that the bed above approaches so near to it that the two become indistinguishable, though the attempt is made to describe them separately. The sections of Plate XXI show this conjunction (of Coal 4, on the 500 feet level, with the bed above it), those of Oldhouse branch and of the head of Middle Fork giving fair working coals.

The bed goes under Middle Fork close above the mouth of Spruce Pine creek, and under Beech Fork near Chumley rock, a cliff of local renown but not unusual height, at the mouth of the branch of the same name.

On Greasy creek the bed is exposed in one seam twenty-four inches thick on the fire-clay, at Elias Howard's on Lick branch, and again on Honey branch (section 64) with four inches of coal below the clay, which here has lost its usual hardness and color, due to iron and bitumen, and has become soft and white.

On and above Laurel Fork, Greasy creek, another unbroken series of thick openings has been developed. On Laurel Fork the least thickness found of the bed is on Fed's (or Fred's) branch, thirty-four inches of coal and six inches of fire-clay parting. On Upper and Lower Double branches openings give seventy-three and forty inches of coal respectively, the former represented in Plate XVII.

On White Oak creek the bed has forty inches of coal, and on Lewis branch, Greasy creek, forty-four inches (Plate

XVII), its single parting of fire-clay comparatively harmless; but on Abner's branch, Greasy creek, the accumulation of seams with eighty-four inches of coal, the lowest part of which belongs to this bed, is so separated by partings as to make it worthless for a long time. (See second coal of section 42 of last year's report.)

At Christopher Lewis', on Wolf creek, the bed is exposed with fourteen inches of coal on the fire-clay, as in section 60, while a neighboring sandstone cliff shows the bed to be completely cut out at that point.

On the waters of the South Fork, besides the openings on Big creek, Leslie county, already mentioned, there is but one other locality where the bed has been found favorable for working. There it is represented by two openings about a quarter mile below the mouth of Indian Grave branch, Left Fork, Goose creek, Clay county; its thickness in one of them fifty-one inches without parting, and in the other forty-six inches and two thin partings. At the Lewis entry, opposite the mouth of Asher Fork, it is reduced to twenty-nine inches without parting.

On Philips Fork, Red Bird creek, Leslie county, besides the thirty inches given in section 93, the bed was found a mile above Elisha Morgan's house with eleven inches of cannel coal, overlaid by eight inches bituminous.

For other openings in Clay county attributed to this bed reference may be had to the sections of Plates XXVIII, XXIX and XXX, and coals at the indicated elevation of 500 feet. Excepting on Hector creek, the distinctive fire-clay has not been found west of Red Bird creek, and there it forms the floor of the bed.

West of Goose creek and its Collins Fork the bed has not been recognized, but, with its elevation of some 400 feet above the conglomerate, it can be found only in the tops of the highest hills, excepting those about the head waters of Collins Fork, where the conglomerate is far below drainage.

Coal 4*a*.

This bed lies generally from fifteen to thirty feet above Coal 4, but is sometimes much closer to it, coming, doubtless, into actual contact in some places, and consequently exhibiting there an unusual thickness. It is clearly impossible to distinguish always between the two.

Though found as a cannel coal at one place only, heretofore, on Troublesome creek, it is now developed as such at various points in the region under discussion.

In southern and western Wolfe county the bed is either wholly absent, or it has been included under Coal 4.

On Stillwater Fork, Frozen creek, Breathitt county, the handsome cannel coal of G. W. Johnson's, described by Mr. Moore, was found to be only eleven inches thick, but the same bed on a branch above G. W. Johnson's house has blocks of double that thickness projecting from the outcrop.

At John Roark's, on Quicksand creek, and on either side of John D. Strong's, on the north side of the river, the bed is found with about thirty inches of coal. On Grapevine creek, Perry county (if not belonging to the bed below, from which it is separated by but five feet of shale and clay), it is thirty-five inches thick (Plate XVI and section 79), and on Ebersole branch, North Fork, with a somewhat increased distance from the lower seam, forty-six inches, of which the lowest eleven inches is cannel coal. (Plate XVI.) Beyond this point its outcrop has not been identified on the North Fork below Lot's creek.

On the Middle Fork, appearing first on Squabble creek, it assumes thence a rather more definite position. On Squabble creek it is found as a cannel coal, thin at the place opened (see section 75), but, from the thickness of blocks seen at an old opening a mile from the mouth of Squabble creek, near the path to Long's creek, it is apparent that a part, at least, of the cannel slate of the section is there replaced by good cannel coal.

Along the Middle Fork up to White Oak branch the bed appears only in thin coal, as shown in sections 73 and 69, and on Wilder branch as an eight inches cannel coal seam in the midst of massive sandstone.

At the mouth of White Oak branch it is made prominent with fifty inches of coal, though its parting of over three feet impairs its value greatly. On Beech Fork, however, at the mouth of Oldhouse branch, its thirty-eight inches of good cannel coal gives it a value elsewhere unattained. Its analysis is given on page 96. This seam of cannel coal may, perhaps, belong to the bed, Coal 4, to which it lies close, as shown in section 66; it is, doubtless, the same seam as the thirty-five inches bituminous in the lowest coal of section 67. While the latter can hardly be treated as a separate bed, the former is given a distinctive character by the quality of its coal.

At all other points in Leslie county the bed has been found only with thin coal. (See sections 59, 60, 61 and 65.)

In Clay county the bed appears quite constantly, varying in distance from Coal 4 from ten feet on Upper Double and Katy's creeks to seventy feet on Tom's branch, Left Fork, Goose creek. Nowhere in the county a cannel coal, and ranging in thickness generally from fifteen to twenty inches, with its maximum thickness, thirty-two inches, on Hector creek, Lick Fork and Red Bird creek.

Coal 4*b*.

This coal lies from thirty feet above Coal 4 in Wolfe county (unless it is there mistaken for Coal 4*a*), to 90 and even 125 feet above it in Clay county.

It has not been found anywhere in the region of workable thickness, though what were supposed to be small pockets of thick coal in the bed were found in the region covered by the report of last year; nor has it anywhere appeared as a cannel coal. Places where it has been found are indicated in the accompanying table, and the corresponding sections furnish a guide for its further identification.

Coal 5.

At a height of 80 to 120 feet above Coal 4, with exceptions in Clay county, lies the coal, well known in Breathitt county as the Haddix coal, designated in recent reports on the North Fork, Kentucky river, as the upper splint coal. Until recently only suspected to be the equivalent of Coal 5 of the north-eastern part of the State, it is now determined to be so without reasonable doubt.

Occurring as a cannel coal in the region now described only in Wolfe and Breathitt counties, its frequent appearance as such, its excellent quality and occasional great thickness, coupled with the difficulty experienced in reaching the solid bed, gives it a peculiar interest there.

This difficulty is probably due to a thick stratum of clay accompanying the coal, giving rise to frequent unusually heavy earth slides from above, which cover the coal and sometimes serve to mark its approximate position. Such a slide has taken place at the head of a hollow in front of Jonathan Elkins' house, Hunting Fork, Holly creek, Wolfe county, estimated to measure 400 feet along the hill by 50 feet on its slope, and a similar slip has occurred at the same elevation behind the house.

At A. M. Swango's, Stillwater creek, cannel coal blocks were found in earth through a distance of twenty-five to thirty feet, search being then abandoned, with the bed supposed to be about two feet thick. Reports elsewhere in the county of random blocks of cannel coal slipping out of the hillsides indicate a nearer constant cannel field than its regular outcroppings can prove.

Even with the steeper hills and greater proportion of sandstone in Breathitt county this tendency to slip is very marked, and caused the discovery of the original Haddix coal, from the face of which its covering was entirely stripped. It is not unlikely that other such deposits may be brought to light in the same way, though the usual effect is to hide them more deeply.

The bituminous stain of the coal is found near the top of the hill at the mouth of Frozen creek, and cannel coal at the head of Stillwater Fork, but neither has been opened. On Cope's Fork, Frozen creek (section 84), the bed exposes but six inches of coal, but it is probable that a search there would discover more. At Wilson's, on the main head of the creek (section 86), the bed is broken up by partings, the lowest four inches cannel coal, but near by, at Green Taulbee's, on Clear Fork, a single seam, without parting, measures forty-two inches, the lower half being a semi-cannel coal; and, again, farther up the main creek, the bed is thirty-six inches thick.

The discovery of a bed, confidently believed to be the same, mainly splint coal, forty-eight inches or more thick, at Isaac Back's, on the head of Middle Fork, Licking river, Magoffin county, should lead to its early development in this locality. Should the bed hold good under the high ridge on which the three counties corner, means of communication by tunnel between the Licking and Kentucky rivers may be easily obtained.

Across the river from William Spencer's, and also from Jackson, cannel coal has been reported, but it has not been seen by the writer; the bituminous stain of the bed shows in the gap on the road from Jackson to Cane creek. A well-defined bench on the level of the bed may be seen almost anywhere in Breathitt county south and west of Jackson, but no openings are known to have been made nearer than the vicinity of the mouth of Troublesome creek, where the Haddix coal is mined. This coal is described by Mr. Moore in his report, elsewhere referred to. His section of the bed at the Sewell mine is given on Plate xv.

On Hayes' branch, Troublesome creek, an abandoned opening gives a thickness of two feet or more, and other outcrops farther up the creek show a rich field in that direction, as indicated in the report of last year.

Above Troublesome creek, besides the forty-two inches of section 55 (last year's report), a recent discovery has been made at Marion Spicer's, on Lick branch, North Fork, sixty-one inches of coal without parting; but efforts to open it elsewhere in this neighborhood have resulted unsuccessfully. On the road from Caney creek to Leatherwood branch cannel coal may be seen in a slip where the bed can only be reached with much labor. The only other opening to be mentioned on the North Fork waters is on Mace's creek, Perry county, where a thickness of coal and shale of thirty-five inches was found, with another seam (or bed) twenty feet below.

On the Middle Fork waters the first appearance of the bed is at Berry Turner's, on Ground Hog branch, Long's creek, with fifty-nine inches of coal much injured by partings (Plate xv, and analysis, page 96), after which, though found at many points along the river (sections 75 to 63), no further thick deposit has been discovered nearer than the base of Pine mountain.

The fifty-five inches, part slikensides coal, at Adrian Metcalf's, on Greasy creek, Harlan county, reported last year as probably belonging to the lower splint bed, is now, from additional data obtained, referred to the upper splint bed, though further work is yet necessary to determine it satisfactorily. Its relation to higher beds is shown in section 62. Another exposure at the forks of Laurel Fork, Greasy creek, evidently in the same bed, has thirty-nine inches of slikensides coal without parting.

In Clay county the bed is as represented in the sections of Plate XXVIII, and in section 102, Plate XXX, nowhere of importance to require especial remark.

Coal 6.

Varying within quite narrow limits, the average distance of this bed from Coal 5, as found from the table of elevations, is about sixty feet.

With a horizon barely cutting the tops of the highest hills of the southern part of Wolfe county, it can be found of considerable area in that county only in the high dividing ridge between Red river and Hunting creek, where no search for it has been made.

In Breathitt county it is opened only at Granville Spicer's, below Canoe Fork, Middle Fork. In his entries, now inaccessible, is reported twenty inches thickness of cannel coal, and six or eight inches bituminous. Some hundreds of bushels of the cannel coal mined have been left exposed on the hill for years, yet it looks perfectly fresh and good, some blocks measuring eighteen inches thick. In quality it appears remarkably fine, having some resemblance to the "curly" Haddix coal (and there is a possibility that it may be ultimately identified with that bed, with a corresponding reduction of the others of section 76), and a part of it showing a change in individual pieces from pure cannel coal to a semi-cannel, like that of Coal 4, on Wolf creek.

On Howard branch, North Fork, it has a promising stain never opened, but other stains seen in the county indicated only thin coal.

At Elijah Davidson's, three miles up Grapevine creek, Perry county, the bed was measured as follows:

Bituminous coal	3″
Clay	4″
Bituminous coal	5″
Rather slaty cannel coal	8″

At John Spencer's, on the same creek, it has fifty-two inches bituminous coal (see section 79 and Plate XVI, and analysis, page 96), but it appears again as cannel coal, twenty-two inches thick, at Samuel Whittaker's, Willard creek. (Section 77.)

The bed has been found at various points on the Middle Fork above Breathitt county (sections 75 to 63), but at only one of them with cannel coal. This is in the river hill a mile below Rush creek, Perry county, where it is ten inches thick and inclosed by twenty-four inches bituminous coal. The only other point at which it was found suitable for working is at G. W. Hoskins', Beech Fork, Middle Fork, Leslie county, forty-four inches of coal. (Section 65 and Plate XVII.)

In Clay county, also, one opening of good thickness has been found (forty inches, Plate XVIII, and analysis, page 96), at Alvis Hubbard's, on Katy's creek. Other openings in the same county show its usual occurrence there as a thin bed. Pieces of cannel coal on the ridge between Big Double and Little creeks are the only evidence of its being a cannel coal yet found in the county.

As in Wolfe county, its horizon overreaches the tops of a large proportion of the hills.

Coal 7.

This bed lies from 200 to 300 feet above Coal 4, its distance increasing towards Pine mountain probably with more regularity than is shown by the table of elevations. Its distance from Coal 6 ranges by that table from thirty to seventy feet.

At J. R. Wilson's, on Frozen creek, Breathitt county, the stain of the bed has been opened over three feet thick in the top of a spur where no solid coal could be had; a better result could be obtained from the adjoining hill.

It is believed that the thirty-nine inches opening of J. Wells', near the mouth of Troublesome creek, described by Mr. Moore, and represented in Plate XV, is in this bed; it is similar to one of sixty inches on the head of Leatherwood branch, Lost creek, reported a year ago (Plate XIV), and of which an analysis is now given in the table, page 96.

Another opening, on John Little's branch, North Fork, gave only nineteen inches of coal, but, having been made in the point of a hill, its full thickness may not have been obtained. On the river side of the hill, on the road from Caney creek up the river, is a heavy stain of the bed, but it is badly slipped.

Above Rock Lick branch, Perry county, the bed was opened with thirty-six inches of coal without parting, reduced to thirty inches some twenty yards under ground. (Section 78.) On Willard creek it was found thirty-two inches thick, and on Big creek, at Alfred Ebersole's, it has sixty-two inches of coal with but two inches parting. (Section 58 and Plate XVI.)

Undiscovered on the Middle Fork, in Breathitt and Perry counties, in Leslie county the bed occurs with some regularity, so far as it has been explored, as a thin bed only.

In Clay county the bed has not yet been opened of working thickness, but a heavy stain near the top of the high ridge between Bullskin and Red Bird creeks, of which the elevation was not obtained, is thought to belong to it.

Coal 8.

This bed, generally about forty-five feet above Coal 7, is the one known about the mouth of Troublesome creek, Breathitt county, as the Flag coal, and described as such in the report of last year. Indications had been found there then of a valuable cannel field or pocket, which later investigations have more fully confirmed.

The greatest development of cannel coal in the bed is in the ridge between the North Fork and Lost creek. Open-

ings near the heads of the branches named below gave the following measurements:

	Mill.	Leatherwood.*	John Little's.*	Lick.
Cannel slate	. . . . . .	4″	. . . .	. . . . . .
Bituminous coal . .	. . . . . .	. . . .	12″	. . . . . .
Shale	. . . . . .	. . . .	2″	. . . . . .
Bituminous coal . .	8″	8″	17″	8″
Shale	2″	8″	2″	11″ (clay)
Bituminous coal . .	25″	27″	6″	10″
Cannel coal	14″	13″ (bitum. c.)	11″	12″

The Lick branch opening is on the south side of the river, the others on the north, and all in the region above the mouth of Troublesome creek. The bottom coal of the Leatherwood branch opening is in detached blocks, similar to those of the cannel coal. The bituminous stain of the bed was found, but not opened, at various other points in this part of the county.

In Perry county an opening, now covered, at Alfred Ebersole's, Big creek, shows that a very good cannel coal was found there, and a thickness of two or three feet or more is indicated. At the head of Mace's creek but thirteen inches bituminous coal was found.

Other openings of the bed in this county, never before reported, are included in the following table:

	John Spencer's, Grapevine Cr. .	Pigeon Roost Branch . . .	S. Whitaker's, Willard Creek, ¼ mile below house.	S. Whitaker's, Willard Creek, 1 mile above house	Alex. Combs', North Fork, below Hazard .
Cannel slate . .	. . . .	. . . . . .	4″	6″	. . . .
Clay	. . . .	. . . . . .	6″	6″	. . . .
Bituminous coal	23″	. . . . . .	. . . .	9″ (can. sl.)	. . . .
Shale	2″	. . . . . .	. . . .	8″	. . . .
Bituminous coal	17″	60″+	48″	45″	39″

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[*] Prior to making this opening several attempts to reach this bed were made, on account of the profusion of cannel blocks which mark its outcrop, by those living in the neighborhood; but all efforts were thwarted by masses of rock which had fallen from above, crushed through the coal, and entirely separated the outcrop from its bed. So it had come to be believed that the outcrop all around the hill was no evidence of a bed of coal extending through it. A similar experience being had by the writer at the above openings, the triumph of the spectator was great—but brief, as the coal was soon found immediately behind the rock.

Slips having caused partial covering of the Willard creek openings before measurements were taken, they are approximate only, but are substantially correct. The thick seam at the bottom of the bed is generally part splint coal, and sometimes a large proportion of it is of this kind.

Analyses of coals from some of the more important openings are given in the table of analyses.

What openings were made in Leslie county disclosed a thin bed, excepting on Wolf and White Oak creeks. On the former it has thirty-seven inches of coal, as in section 50; on the latter it was opened in several places, and its changes and relation to the bed, or seams of coal under it (Coal 7), are exhibited below. Openings in the same seam are placed in line horizontally, the upper group alone representing Coal 8:

At C. K. York's, White Oak Cr'k.	¾ mile up Right Fork from J. Turner's.	¼ mile up Rig't Fork from J. Turner's.	½ mile up Left F'k from J. Turner's.
Shale. . 3″+ Coal . . 3″ Shale . 35″ Coal . . 9″	Shale . . . . 4″+ Coal . . . . . 3″ Shale . . . . 9″ Coal . . . . . 9″ Clay.	Coal stain.	Shale , . . 90″+ Coal . . . . 2″ Shale, iron o. 10″ Splint coal . 36″ Clay.
45′ { 35′ covered. 5′ sandstone. 4′ shale. 1′ sandstone.	20′ { Covered.	20′ { Covered.	
Bitum. coal . . 19″	Bitum. coal. . . . 14″	Bit. c. & can. sl . 9″	
8′ { Covered. Shale.	9′ { Shale. . . . . . 8″ Covered. 2′+ yellow shale.	9′ { Covered. 2′ yellow shale.	
Coal . . . . 1″ Shale . . . 12″ Splint coal . 15″	Coal . . . . . . 8″ Shale . . . . . . 2″ Splint coal . . . 4″	Block bit. c. . 11″	

A considerable upward pitch of the beds on the Right Fork, towards Old Roan creek, would have led to a misconception of their number and position had they not been examined carefully.

The single opening in this bed in Clay county, on Katy's creek (the upper bed of section 95), gives little intimation of what it may develop, though it is too high to be found of sufficient area for working elsewhere in the county than near the head of Red Bird creek and of the Left Fork, Goose creek.

It may well be remarked, as indicative of the lack of development of nearly the whole region, and particularly of the higher beds, that all but three or four of the openings in this bed named above were opened last year under the direction of the Survey.

Coal 9.

The few openings that have been made into this bed show it well worth a more thorough search. Fifty to seventy-five feet above Coal 8 it lies on the top of a hard sandstone and below much softer rock, so that a very broad bench is often formed, which marks the place of the coal distinctly, but serves for hiding it effectually.

Its place in Breathitt county appears to be not far below the top of the high peak at the heads of Frozen and Hunting creeks and Red river. Cutting only the highest peaks to the south-east, it should still have a working area in Flint ridge, but it has never been looked for there. Its only opening in the county is on Markham branch, North Fork, where its thickness, not fully obtained, is more than three feet.

At Abner Campbell's, on Fish-trap branch, Perry county, the bed has its greatest thickness, fifty-six inches without parting, of which the lower half is a fine splint coal, and the whole of excellent quality.

On Hell-for-Certain creek, Leslie county, its bench is distinct, but its stain gives no indication of its thickness. On White Oak creek but fourteen inches of coal was found; but at Wesley McFadden's, on Hal's Fork, Big creek, the bed has sixty-one inches of coal, as shown in Plate XVIII.

Analyses of the thick coals of this bed are given in the table, page 96.

On Lick Fork, Red Bird creek, Bell county, the bed has twenty-one inches of coal. In Clay county it has not yet been found.

Coal 10.

Sixty-five to ninety feet above Coal 9 is another bed, which, though high in the hills, carries sometimes sufficient coal to give it considerable importance. Though having some little cannel coal in it, not enough has been found to increase its value materially.

The bed probably overreaches all the hills of Breathitt county. In Perry county its place is marked by a prominent bench near the tops of the highest hills, indicated in sections 79 and 77. At the head of Fish-trap branch its stain is found; but no opening in the coal has been made lower down the North Fork than Big creek.

At John Fields', on that stream, it was opened, measured, and the lower part sampled by James J. Profitt, soon after which the opening caved in. His measurements (sixty-one inches of coal, including six inches of cannel) are given in Plate XVI, and the analysis of his sample with others in the table.

At Mace's creek, the only other opening of the bed on the North Fork waters, the coal was found thin.

On the Middle Fork, in Leslie county, the bed runs from twelve to twenty-nine inches thick as found along its main course, but on Beech Fork it is found again with about five feet of coal, on Oldhouse and Reuben branches. (Sections 66 and 65 and Plate XVII, and for analyses, page 96)

At points of sections on the waters of Greasy and Cutshin creeks the bed was found in each instance, but no working seam developed; it is quite possible, however, that the one at Magyard's, on Cutshin creek, which was imperfectly opened, might give a better result if fairly developed; and also that at Metcalf's (section 62), in which some of the five partings are likely to disappear in working to solid coal, the opening having been carried barely far enough to distinguish coal from shale, and none other showing such an intermixture.

The bed has not been found in Clay county; but just across the line, in Bell county, on Lick Fork, Red Bird creek, it has in its several seams a thickness of over four feet—a strong inducement for further search in that vicinity. It is the top bed of section 94.

Coal 11.

In the high hills about the heads of Greasy creek, Harlan and Leslie counties, about 200 feet above Coal 10, lies a body of thick coal shown in sections 61, 62 and 63, which for present purposes may be called Coal 11, though it is not unlikely that some intermediate bed may yet be found, which, eventually, will take this number, and scarcely probable that at any time can these upper beds be fully identified with those of the north-eastern part of the State.

The bed has its greatest thickness of coal, eighty-three inches, at the head of Pace Trace, White Oak creek, but its area is confined to a narrow limit in the top of a high ridge. On Upper Double branch the hills are much higher, and, though much injured by partings, the sixty-four inches of coal there will in time become valuable. (See for these openings Plate XVII, and also analyses.) On Gill branch, Laurel Fork, Harlan county, but forty-one inches of coal was seen in an imperfect opening, which, perhaps, might have developed more.

Other openings in this bed were made at the head of Middle Fork and on Harmon branch (sections 67 and 69), the former with a thickness of forty-two inches, the latter with but nineteen inches of coal.

Coal 12.

No opening has been made into this bed, and its stain has been seen only at Nicholas Schell's, on Upper Double branch (section 63), where it lies forty feet above Coal 11. It is probably from two to four feet thick there.

Coals Excluded from the Table of Elevations.

In section 70 is a seventeen inches seam of coal lying thirty feet above the lowest coal of the section. This may be an offshoot from the bed below, or, perhaps, more likely, should be called Coal *2a*, but as no equivalent to it appears elsewhere in the region, it is preferred to omit it in the table as a local interpolation.

Again, in section 69, a seam thirty-five feet below the highest bed there, having twenty-one inches of coal, has no place in the table for a like reason. Its distances from the seams above and below are large for its consideration as attached to them, and are correct, the three seams being exposed directly above one another.

Coals below the top of the conglomerate are

Inter and Sub-Conglomerate Coals.

These beds reach the surface only in the western part of Wolfe and Clay counties, and are not known to be of workable thickness in either county. Sections 91 and 92 show their positions in Wolfe county at the mouth of Clifty creek and on Lower Devil creek, as nearly as could be ascertained in the short time allotted to them.

Exposed in the cliff opposite the mouth of Clifty creek there are two thin coal seams in the shale which separates the two sandstones of the conglomerate there, and two or three seams between the bottom of the lower conglomerate sandstone and the top of the limestone below it. The bed reported in the river at the mouth of this creek, two or three feet thick, is the only one which has any probable value.

On Chimney-top creek this bed appears to be absent, only an eighteen inches seam being found, five to ten feet below the lower conglomerate sandstone, which here is but fifty feet above the limestone. This seam probably corresponds with the fifteen inches seam of section 92.

On Lower Devil creek a coal appears from under the stream between Whistman's mill and the ford below.*

It is said, also, that coal has been found in the inter-conglomerate shale there, as found near Clifty creek.

It is probable that the deep-cutting streams of this southwestern part of the county expose many miles of outcrop of the bed, three to five feet thick, mined at Beattyville; but as yet no such thickness has been discovered.

In Clay county no attempt was made to find any of these beds. It is not likely that the lower ones reach the surface, and the upper ones are, doubtless, inconsiderable. An eight inches seam, supposed to be about fifty feet below the top of the conglomerate, showing on the Little Goose creek road about five miles from Manchester, is the only one seen by the writer.

On the following pages are tables of analyses of some of the principal coals and of the comparative elevations of beds previously explained and referred to. Samples were averaged in the usual manner, excepting some cannels, which have been specified:

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*Permission to open this bed was refused by Mr. Whistman.

ANALYSES OF COALS BY DR. R. PETER, Chemist of the Kentucky Geological Survey.

Designation of Bed	LOCATION.	Total thickness of coal—Inches . .	Specific gravity .	Moisture	Volatile combustible matter . . .	Fixed carbon . .	Ash	Sulphur	Character of coke.
11	N. Schell's, Upper Double Branch, Leslie county	64	1.363	1.72	35.68	62.60	*11.40	1.367	Light spongy.
11	Pace Trace, White Oak creek, Leslie county (lower 53″) .	83	1.509	9.40	32.20	58.40	*9.60	0.433	Pulverulent.
10	John Fields', Big creek, Perry county	61	1.333	3.50	35.30	61.20	*8.06	1.035	Dense.
10	Dale Bledsoe's, Reuben Branch, Harlan county	63	. . . .	1.60	33.30	65.10	*15.40	1.491	Dense spongy.
10	Silas Nantz's, Oldhouse Branch, Leslie county	46	1.502	1.30	32.36	66.34	*16.00	1.409	Dense spongy.
9	Abner Campbell's, Fish-trap Branch, Perry county . . .	56	1.359	5.26	30.34	64.40	9.20	0.475	Friable. . . .
9	Wm. McFadden's, Hal's Fork, Leslie county	61	1.322	1.60	34.94	63.46	*8.00	1.066	Dense spongy.
8	Alex. Combs', below Hazard, North Fork, Perry county.	39	1.290	1.76	36.04	62.20	6.00	0.557	Light spongy.
8	Samuel Whittaker's, Willard creek, Perry county . . .	45	1.390	3.96	32.84	63.20	*10.40	0.722	Friable.
8	John Spencer's, Grapevine creek, Perry co. (lower 48″) .	52	1.366	4.36	30.34	65.30	10.40	0.450	Friable.
8	Gough & Co.'s, John Little Br. Breathitt co. (middle seam)	46	1.410	7.40	30.20	62.40	*10.36	0.621	Pulverulent.
8	Gough & Co.'s, John Little Branch, Breathitt co. (cannel) .	46	1.177	1.20	53.80	45.00	5.54	0.722	Dense.
8	Head of Leatherwood Branch, Breathitt county	43	1.384	2.80	31.16	66.04	*12.70	0.690	Dense. . . .
7	Head of Leatherwood Branch, Breathitt county	60	. . . .	9.60	29.46	60.94	*16.80	0.478	Pulverulent.
6	John Spencer's, Grapevine creek, Perry county	40	. . . .	6.48	30.32	63.20	*15.40	0.491	Pulverulent.
6	Middle Fork, below Rush Branch, Perry co. (cannel 10″)	34	. . . .	0.80	44.80	54.40	16.80	0.970	Pulverulent.
6	Alvis Hubbard's, Katy's creek, Clay county	38	1.290	1.60	34.28	64.12	*9.30	1.766	Dense spongy.
5	B. Turner's, Long's creek, Breathitt county (lower 30″) .	59	1.275	2.00	35.36	62.64	*5.28	1.019	Light spongy.
5	Green Taulbee's, Clear Fork, Breathitt county	42	1.310	3.80	34.40	61.80	10.00	0.585	Dense.
4a	J. Ledington's, mouth Oldhouse Br., Leslie co. (cannel) .	38	. . . .	1.10	44.20	54.70	*11.00	0.690	Dense.
4	Lewis' Branch, Greasy creek, Leslie county	44	1.251	1.72	35.02	63.26	*5.66	0.599	Light spongy.
4	Mc. C. Schell's, Upper Double Branch, Leslie county . .	73	1.342	3.20	29.70	67.10	*9.60	0.626	Dense.
4	Jesse Morgan's, Burnt Camp Branch, Leslie county . . .	65	1.291	0.70	34.70	64.60	*9.40	0.983	Spongy.
4	Wm. Sisemore's, Rockhouse creek, Leslie co. (upper 63″)	69	1.279	0.74	36.06	63.20	9.20	1.307	Spongy.
4	Mouth of Guy's creek, Perry county (upper 32″) . . .	48	1.366	3.40	31.00	65.60	*10.30	0.557	Friable.
4	Peter Gross, mouth of Squabble creek, Perry county . .	36	1.259	1.90	37.10	61.00	8.10	0.749	Spongy.

4	J. Campbell's, mouth of Rock Lick Branch, Perry co. . .	39	. . . .	2.80	29.60	67.60	*9.10	0.505	Friable.
4	Thos. Johnson's, Ebersole Branch, Perry county	45	1.334	3.30	34.90	61.80	*9.60	0.763	Friable.
4	J. Deacon's, Caney creek, Breathitt co. (lower 27″ bit.) .	42	. . . .	3.80	32.30	63.90	*15.10	0.840	Pulverulent.
4	J. Deacon's, Caney creek, Breathitt county (cannel 9″) .	42	. . . .	0.80	41.70	57.50	*24 20	0 952	Pulverulent.
4	J. Deacon's, Wolf creek, Breathitt county	88	1.351	2.80	33.60	63 60	9.40	0.695	Dense.
4	Crawford's, Beginning Branch, Breathitt co. (cannel) . .	18	1.274	1.00	41.10	57.90	11.20	1.120	Dense.
4	I. Jackson's, mouth of Indian Grave Branch, Clay co. . .	51	1.288	1.10	35.60	63.30	*6.40	0.885	Light spongy.
4	R. Collins', Hal's Fork, Big creek, Leslie county	57	1.285	1.40	35.68	62.92	*4.00	0.667	Light spongy.
3	J. T. Smith's, Tom's Branch, Clay co. (bituminous 30″) .	35	. . . .	2.80	29.40	67.80	10.80	1.178	Dense friable.
3	J. T. Smith's, Tom's Branch, Clay county (cannel 5″) .	35	1.160	0.30	44.16	55.54	11.80	1.244	. . . .
2	Wm. Bowling's, Rush creek, Perry county (upper 20″) .	44	1.279	1.20	39 60	59.20	6.50	1.327	Spongy.
2	Wm. Bowling's, Rush creek, Perry county (lower 20″) .	44	1.300	1.20	35.90	62.90	7.60	0.654	Light spongy.
2	Mrs. S. A. White's, Left Fork, Goose creek, Clay county	39	1.278	1.48	35.92	62.60	7.90	0.885	Light spongy.
1*a*	J. M. Jones', Beech creek, Clay county (bituminous 32″) .	47	1.313	0 92	37.54	61.54	*8.10	1.601	Light spongy.
1*a*	J. M. Jones', Beech creek, Clay county (cannel 15″) . .	47	. . . .	0.42	32.38	67.20	*32.00	6.042	Dense.
1	T. T. Garrard's, east side of Goose creek, Clay county . .	31	1.287	1.20	38.10	60.70	5.80	1.793	Light spongy.
1	J. L. Hornsby's, Laurel creek, Clay county	45	1.292	1.46	34.84	63.70	6.00	0.531	Light spongy.

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* Muddy outcrop sample.

TABLE SHOWING RELATIVE ELEVATIONS OF BEDS.

Compiled from Accompanying Sections.

Sec. No.	LOCATION.	Initial of county..	Coal 1 .	Coal 1*a* .	Coal 2 .	Coal 3 .	Coal 3*a* .	Coal 4 .	Coal 4*a* .	Coal 4*b* .	Coal 5 .	Limestone.
57	Mace's creek	P.						500			610	I. ore.
58	Big creek	P.						500		580		
59	Cutshin creek	L.					445	**500**	530		605	
60	Wolf creek	L.						500	515	560	625	
61	White Oak creek	L.						**500**	515	555		
62	Laurel Fork	H.									**595**	
63	Upper Double Branch	L.						**500**			590	Fossil.
64	Honey Branch	L.					465	500			595	
65	Beech Fork	L. & H.				395	480	500	510			
66	Oldhouse Branch	L.					490	***500**	525	570		
67	Head of Middle Fork	L.						**500**				
68	White Oak Branch	L.				405	*440	**500**	**535**			
69	Saltwell Branch	L.				400		500	535		625	
70	Middle Fork above Hyden	L.			305	435	485	500		550	585	
71	Rockhouse creek	L.						500			610	
72	Bull creek	L.				390		500		565	590	
73	Hell-for-Certain creek	L.				400		500	525	550	570	
74	Grassy Branch	L. & P.				400		500			580	
75	Squabble creek	P.		240				**500**	*525		**590**	
76	Canoe Fork	Br.		305		395	460	500				
77	Willard creek	P.					440	500				
78	Fish-trap Branch	P.					455	**500**				
79	Grapevine creek	P.				390		**500**	510	565		
80	Lick Branch	Br.				405	450	***500**		555	595	
81	Quicksand creek	Br.			295	360	*430	500	**525**		595	640
82	Big Pan Bowl Branch	Br.				370		500			610	
83	Jackson	Br.				**360**	415	500		570	*620	
84	Cope's Fork	Br.			315	360	415	500	515		580	605

85	Mouth of Frozen creek	Br.	**215**	....	270	**400**	420	....	....	....	580	....
86	Head Frozen creek	Br.	....	....	....	445	....	500	....	....	***585**	645
87	Stillwater Fork	Br.	....	....	365	430	450	500	*515	....	*605	635
88	Holly creek	Br. & W.	290	325	....	420	465	500	....	545	*590	....
89	Stillwater creek	W.	....	....	395	455	....	500	....	580	*590	615
90	Campton	W.	....	325	385	450	....	500	....	535	....	....
91	Lower Devil creek	W.	These sections show coals below top of conglomerate only.									
92	Mouth of Clifty creek	W.										
93	Philip's Fork	L.	....	....	....	....	450	*500	....	....	605	....
94	Lick Fork	C. & Bl.	....	....	....	....	415	500	530	....	580	....
95	Katy's creek	C.	....	....	....	....	....	500	510	550	630	....
96	Upper Double creek	C.	....	....	....	315	370	500	510	590	685	....
97	Hal's Fork	L.	....	....	....	....	410	**500**	530	....	....	....
98	Bullskin creek	C.	75	165	225	325	....	500	515	....	....	....
99	Hector creek	C.	105	....	240	365	....	500	515	....	....	....
100	Beech creek	C.	115	***160**	215	....	405	....	....	....	....	....
101	Indian Grave Branch	C.	....	....	....	....	....	***500**	535	590	....	....
102	Tom's Branch	C.	....	....	....	*340	....	**500**	570	625	665	700
103	Collins' Fork	C.	....	....	250	**345**	465	....	....	625	....	....
104	Collins' Fork	K.	....	....	260	*320	390	500	....	....	....	....

* Cannel coal. Bold-faced type denote a thickness of coal of three feet or more in the vicinity of the section.

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TABLE SHOWING RELATIVE ELEVATIONS OF BEDS.—Continued.

Sec. No..	LOCATION.	Initial of county .	Coal 6 .	Coal 7 .	Coal 8 .	Coal 9 .	Iron ore .	Coal 10 .	Coal 11 .	Coal 12 .	Iron ore .
57	Mace's creek	P.		800	850			1000			
58	Big creek	P.		**775**	*815			***970**			
59	Cutshin creek	L.		750	780			910			
60	Wolf creek	L.	670	780	**810**		I. ore.	*925			
61	White Oak creek	L.		745	**795**	860		930	**1130**		1200
62	Laurel Fork	H.		735			890	**920**	**1130**		1340
63	Upper Double Branch	L.	635			910			**1220**	1260	1320
64	Honey Branch	L.	650	790	860			950			
65	Beech Fork	L & H.	**660**	810	880			**980**			
66	Oldhouse Branch	L.	670		865			935			
67	Head of Middle Fork	L.	655					925	1105		
68	White Oak Branch	L,			850						
69	Saltwell Branch	L.	695					975	1055		
70	Middle Fork above Hyden	L.		725	800						
71	Rockhouse creek	L.		700				910			
72	Bull creek	L.		705							
73	Hell-for-Certain creek	L.	655	710	†	880		975			
74	Grassy Branch	L. & P.		700							
75	Squabble creek	P.	645								
76	Canoe Fork	Br.	*645								
77	Willard creek	P.	*660	725	**790**			970			
78	Fish-trap Branch	P.		**735**		**845**		900			
79	Grapevine creek	P.	***690**		**800**	855		895			
80	Lick Branch	Br.	685		*760	‡					
81	Quicksand creek	Br.									
82	Big Pan Bowl Branch	Br.									
83	Jackson	Br.									
84	Cope's Fork	Br.									
85	Mouth of Frozen creek	Br.									
86	Head Frozen creek	Br.		725			950				

87	Stillwater Fork	Br.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
88	Holly creek	Br. & W.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
89	Stillwater creek	W.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
90	Campton	W.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
91	Lower Devil creek	W.	These sections show coals below top of conglomerate only.								
92	Mouth of Clifty creek	W.									
93	Philip's Fork.	L.	. . . .	. . . .	790	. . . .	. . . .	965	. . . .	. . . .	. . . .
94	Lick Fork	C. & Bl.	650	. . . .	. . . .	**845**	. . . .	**970**	. . . .	. . . .	. . . .
95	Katy's creek	C.	**675**	. . . .	770	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
96	Upper Double creek	C.	*715	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
97	Hal's Fork	L.	. . . .	. . . .	. . . .	**820**	. . . .	. . . .	. . . .	. . . .	. . . .
98	Bullskin creek	C.	. . . .	?	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
99	Hector creek	C.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
100	Beech creek	C.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
101	Indian Grave Branch	C.	730	775	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
102	Tom's Branch	C.	740	780	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
103	Collins' Fork	C.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
104	Collins' Fork	K.	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .

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* Cannel coal. † Black fossiliferous limestone at elevation 845. ‡ Iron ore at elevation about 790. Bold-faced type denote a thickness of coal of three feet or more in the vicinity of the section.

Recapitulation.

From the foregoing details the following prominent features of the various beds in the region discussed are extracted:

Sub and inter-conglomerate coals reach the surface only in south-western Wolfe, and, possibly, Clay counties. So far as found they are without economic value.*

Coal 1 has a large area developed in Wolfe county and lower Breathitt, on the North Fork, ranging from two to three feet in thickness. It is the least variable of all the beds; is an excellent bituminous coal with some splint, and promises, unlike its equivalent farther north, to become an important coking coal.

In Clay county the coal is much used for local consumption on Goose creek, where it is two and a half to three feet thick, but it gives no indication of possessing coking qualities.

Coal 1a is a thin cannel coal in Wolfe county, without working value. Elsewhere it occurs only as a thin bituminous coal, excepting on Beech creek, Clay county, where there is about one foot of cannel overlaid by two and a half feet of bituminous coal.

Coal 2 is not found as a cannel, and carries but little splint coal. It reaches a thickness of over two and a half feet on Long's creek, where it is an exceptionally fine coal, and will probably become an important working bed along the Middle Fork in Perry county, where it reaches a thickness of over three and a half feet.

In Clay county its single thick opening on Left Fork, Goose creek, promises well for that vicinity only.

Coal 3, the "Elkhorn" coal, is found as a superior coking coal in a thick pocket in Wolfe county. It is found as a cannel coal in Breathitt county, but in thin seams only. An extensive field of coal, three and a half to four and a half feet thick, probably also suited for coking, has been well developed along the North Fork from Bloody creek to Stray branch. Another hardly less important field, with a thickness reaching up to five feet of coal, is found on the Middle Fork extending from below Hyden, Leslie county, nearly to the mouth of Beech Fork. These fields are somewhat interrupted by areas of thin coal, probably small.

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*The main sub-conglomerate, or Three Forks coal, is below the surface in the region described.

In Clay county the bed again carries a thin seam of cannel coal, and this can be profitably worked on Left Fork, Goose creek. Evidence is found pointing to the extension of this field as bituminous coal only, through from one fork of Goose creek to the other.

Coal 3a is generally a thin bituminous coal, with occasional pockets of cannel, one of which has been considerably worked near the mouth of Quicksand creek, Breathitt county.

Coal 4, the most important bed, is the "lower splint" of previous reports, sometimes a cannel coal. In Leslie county, and parts of counties adjoining, it is conspicuously marked by a persistent thin parting of non-plastic fire-clay, on account of which it is made the base in grouping sections at an assumed elevation of 500 feet.

Working seams are found in the southern part of Wolfe county, but they appear to be limited to pockets.

Above the mouth of Troublesome creek, Breathitt county, frequent openings show an immense area of coal, varying from two and a half to over seven feet in thickness, and containing pockets of cannel coal of good thickness and quality. Thick deposits are found along the North Fork nearly through Perry county, and one is believed to extend from the North Fork across Middle Fork—on Ebersole branch and Guy's creek, and down to Squabble creek, where it yields the purest bituminous coal of the region.

Another larger, and still more promising field—favorable in the more uniformly thick coal found—extends in Leslie county from Rockhouse creek, up the Middle Fork and Cutshin creek to the points at which the bed disappears below those streams, and nearly the full length of Greasy creek. Of the many openings made in it scarcely any give a thickness of coal of less than three feet.

On the waters of South Fork the coal is generally thin, exceptional thick deposits lying near the heads of Big creek, Leslie county, and Left Fork, Goose creek, Clay county, which are not unlikely to prove of considerable extent.

Coal 4a carries cannel coal over a greater area than any of the other beds, but, where of workable thickness, the cannel is probably still in pockets. It lies frequently so near Coal 4 that both beds are made more valuable thereby, and it appears that they are sometimes in contact.

In lower Breathitt it has been developed as a cannel coal without the discovery of any thick deposit. Its openings of nearly three and four feet, on Grapevine creek and Ebersole branch, North Fork, alone indicate a considerable working field in that part of Perry county: the latter thickness includes eleven inches of cannel coal.

Near the head of Middle Fork and on Beech Fork, Leslie county, it again becomes prominent, with over four feet of bituminous coal on the former stream, and thirty-eight inches cannel on the latter.

Coal 4b has been found only in thin seams, though its previous discovery as thick coal, elsewhere, leads to the expectation of finding similar deposits in this region.

Coal 5, the "upper splint," is another important bed, containing cannel in Wolfe and Breathitt counties.

Near the head of Frozen creek, Breathitt county, it is three to three and a half feet thick, part splint and semi-cannel coal, and probably over four feet thick across the hill in Magoffin county. About the mouth of Troublesome creek is an irregular field with coal from three and a half to five feet thick, including the Haddix coal with its three feet of fine cannel. Unusual difficulty in opening the bed has undoubtedly prevented finding much other valuable cannel coal in this vicinity. A five feet opening on Long's creek probably marks the south-western limit of the field.

Along the base of Pine mountain, Harlan county, it is three to four and a half feet thick, slikensides coal, as shown by exposures at the forks of Laurel Fork and of Greasy creek.

Coal 6 is frequently in part cannel coal, but as yet has been found with a workable seam of it only on the Middle Fork below Rush creek, Perry county. Scattering openings made in bituminous coal, three to five feet thick, show it to be of some importance; these are on Grapevine creek, Perry county; Beech Fork, Middle Fork, Leslie county, and Katy's creek, Clay county.

Coal 7 is of working thickness on the head of Frozen creek, Breathitt county, and over a considerable area about the mouth of Troublesome creek openings have discovered a field, with five feet maximum thickness, which may extend to the Perry county line. Thick coal is found also in Perry county on the North Fork above Rock Lick branch, and on Big creek; and in Clay county probably on Bullskin creek.

Coal 8, above the mouth of Troublesome creek, is an important cannel bed four feet thick, with about one foot cannel. Along the North Fork, in Perry county, openings indicate a constant thickness of three to five feet. In Leslie county, three feet on Wolfe and White Oak creeks gives some promise of a considerable field there.

Coal 9 has but few openings, of which the principal are: Markham branch, North Fork, Breathitt county, three feet; Fish-trap branch, North Fork, Perry county, four and a half feet, and Big creek, Leslie county, five feet.

Coal 10 has five feet of coal on Big creek, Perry county, and on Reuben and Oldhouse branches, Beech Fork, Leslie county. Probably an excellent working bed will be developed in Kentucky ridge in Harlan and Bell counties, and in its northward spurs.

Coal 11 has seven feet of coal at the head of White Oak creek, Leslie county, but it has sufficient area for working only on the south side of Greasy creek, where it is five feet thick on Laurel Fork and three and a half feet on the head of Middle Fork.

Coal 12 has been found, but has not been investigated.

Iron Ore.

Of the iron ore in the region under discussion that about the head waters of the Middle Fork, in Leslie and Harlan counties, alone appears to be in abundant quantity. Some intimation of this was given in the report of last year, and though still imperfectly developed there, it is now ascertained almost beyond question that the ore will compare favorably, in quantity and quality, with most of the furnace regions of North-eastern Kentucky. The valuable ores all lie above Coal 5, as seen in the accompanying sections, are generally calcareous, apparently rich in iron and free from silica. Diminishing in quantity northward, their limit may be considered reached at the Leslie and Perry county line, and on the west at the ridge between Middle Fork and Red Bird creek.

There are, however, numerous smaller deposits in Perry and Breathitt counties, and occasional ones in Wolfe and Clay counties. Among these are noted, in Breathitt county, a bed close above Coal 5, quite plentiful about the heads of the small streams above Troublesome creek, but too sandy to be of value, and a bed twenty to forty feet above Coal 1, which on Frozen creek appears good; but, extending into Wolfe county as far as Campton, is also sandy in its greater part.

The lower limestone ore of the Red river is found as far up as its place lies above the river bed, but it probably diminishes in quantity eastward to that point, and southward also, as none of it was seen south of the Red river.

A most unusual occurrence of ore is found at John Clemens' at the head of South Quicksand creek, Breathitt county, where it lies in a vertical fissure vein about eighty feet above a coal opening, probably Coal 4, and about one hundred feet below a bench said to carry a fine quality of calcareous iron ore. The vein would appear to be near the level of the ore bed next above Coal 5.

An opening in the sharp point of a hill follows the vein down to a depth of about ten feet, between walls two to three feet apart, of sandstone lying horizontally. The vein filling is of earth, through which runs, parallel to the walls, a continuous seam of pure hematite, two to eight inches thick, small scattering pieces of ore, also lying vertically, being adjacent to the main seam. At the bottom of the pit the vein is said to make a sharp turn, and continue horizontally on the top of a thin bed of coal. The exploration was abandoned after following about five feet in this direction, and the place is now partly refilled with earth.

The vein was excavated from the surface a length of eight feet, beyond which no search for it was made. Its direction is about east and west. The opinion first formed by the writer, that the fissure was made by the breaking of the cliff of a former "rock-house," is brought to question by the credible report by Mr. Clemens of other singular formations in the vicinity.

Limestone.

The sub-carboniferous limestone, exposed in cliffs of Red river and its branches in Wolfe county, and again in those of Pine mountain, in Harlan county, is the only constant limestone in the region, and it is below drainage almost altogether.

The ferriferous limestone of the "Hanging Rock" iron district crops out at frequent intervals on the north side of the North Fork, in Breathitt county, never more than five feet thick, and usually impure. An attempt to make lime from that of A. C. Cope's, on Frozen creek, is said to have resulted successfully, but most of the rock is unfit for it.

The calcareous concretions of the lower shales are abundant in Wolfe county, over Coal 1, in layers three or four inches thick, and serve for a mark in tracing the lower beds. Less numerous layers are found, however, in the shales above Coals 2 and 3—in the latter as far south as Grapevine creek, Perry county.

Large calcareous bowlders have been noted only in Breathitt county, north of the mouth of Troublesome creek, where they lie immediately above Coal 3.

The hard, black, fossiliferous limestone of section 73, of which no counterpart has been discovered elsewhere in the region, lies, about five feet thick, at the head of Peach Orchard branch, the next stream below Hell - for - Certain creek, Leslie county.

In Clay county a thin limestone at J. T. Smith's, Tom's branch, Red Bird creek, is the only one which has come to the notice of the writer.

Conglomerate.

The outcrop of the conglomerate is roughly indicated in the opening pages of this report; some further comment upon it is desirable.

In Wolfe county the formation may be said to include two benches of sandstone, containing quartz pebbles in greater or less profusion, with an intervening stratum of shales, the whole approximately 200 feet thick on the Red river, and undetermined on the waters of the North Fork, Kentucky river.

Between the conglomerate, as defined above, and the sub-carboniferous limestone, is a stratum of shale 100 feet thick, at the mouth of Swift's Camp creek, and but fifty feet near the mouth of Chimney-top creek. The thickness of this shale is easily determined on Red river, but becomes uncertain in the south-western part of the county.

On the Red river the upper bench of sandstone carries a profusion of pebbles, while the lower bench has but few. On the North Fork waters neither bench has many, the number constantly decreasing toward the south; so that in Breathitt county they become a rarity, and where the upper part alone of the formation is exposed, careful examination is required to distinguish it.

Especial difficulty is met because of its very irregular surface—much more uneven than that of the coal stratum immediately above it.

An example of this irregularity is evident near Campton. Swift's Camp creek there runs on the top of the conglomerate, and also a branch of the creek on its top two miles westward on the Winchester road. The branch is about 100 feet above the main stream, and the consequent slope of the conglomerate has no counterpart in the strata above, as may be seen from the smooth and nearly level benches along the hills between the two points. No evidence of non-conformation has been found, however, which can not be accounted for on the supposition that the first coal strata were deposited on a very uneven bed, which sometimes even protruded above the level of the coal-forming swamps.

The flat creek bottoms, generally found just above the points where the streams begin to cut through the hard top of the conglomerate, are often a guide to its location where the rock itself can not be seen, though the bottoms usually rise almost imperceptibly onto higher strata. Once the cut is begun, an exposure of a five-feet layer of cross-laminated sandstone, five to fifteen feet from the top, is often found; and this is the principal means of identification of the rock in Breathitt county, though occasional pebbles still may be found in it.

By this cross-cleavage the rock is recognized as reappearing on Holly creek, below Mrs. Hollin's, where it is cut into by the stream ten to fifteen feet, though farther down, near the mouth of Hunting Fork, it is below the stream bed.

A like elevation has taken place on Stillwater Fork, Frozen creek, and it is believed that the cliffs reaching a height of about fifty feet on main Frozen creek, between Cope's Fork and Davis branch, are of the conglomerate formation, though it must be admitted that the principal evidence found is in their gorge-like character. The lower coal, and other beds lying at an easy slope on either side of this mass of rock, are supposed to have their edges abutting against it, while higher ones lie smoothly over it. On Cope's Fork no such cliffs appear.

Between the North and Middle Forks irregularities of this nature have not been found, stream beds rising rapidly to the top of the conglomerate, and then continuing on and above the top to their beginning.

In Clay county no inherent peculiarity has been discovered in this formation by which its rocks may be distinguished from others, excepting its tendency toward the formation of cliffs where it is particularly durable. These cliffs have been mentioned already.

Their frequent sudden terminations and apparent replacement by sandy shales (taking also into consideration the shaly character of the formation towards the mouth of the South Fork) are indicative of a large area of conglomerate shale outcrop replacing the upper sandstone in the western part of the county.

Probably the strongest evidence in this direction is to be found near J. L. Hornsby's, on Laurel creek. There the sandstone cliff rises about forty feet from the creek and is capped by a bed of coal which can only be regarded as Coal 1 —the same bed that is found along Goose creek. A mile above Hornsby's what appears to be the same bed is 100 feet above the creek, a uniform shale reaching from the creek to the coal.

This shale, indeed, is so sandy that it might nearly as well be called a very fine-grained sandstone. Where exposed to the weather it disintegrates like ordinary shale, but the fresh rock has little appearance of it, and has even a slight ring, as of limestone. It gives a good light soil to the bottom lands of much of this part of the county.

Another view of the formation worth considering is, that the cliff-forming sandstone is the top of the conglomerate and the shale a subsequent deposit. This induces belief that the upper surface of the conglomerate is extremely uneven, and that, previous to the growth of any material forming coal, the depressions of the rock were filled with shale, such as has no place in the series north of the Middle Fork. Further study of this question in the field is necessary for its solution.

Sandstone.

The sandstone of the region has the usual characteristics of the formation, the numerous stone chimneys constructed showing that an abundant supply for local use, of easily worked and good building stone, may be had in any part of it.

Notably between the North and Middle Forks, in Perry county, and between the Middle and South Forks, from Long's creek, Breathitt county, to Rockhouse creek, Leslie county, the sandstone above Coal 8 (Mahoning sandstone) assumes a prominence which, it is believed, will be a material aid in a more thorough investigation of the measures there. At various points on these ridges its great resistance to weathering has given a comparatively broad and flat top to the hills, in marked contrast to their usual narrow summits. Most prominent among them is that at the head of Squabble creek, Perry county, where the gap to Buffalo creek is on the top of the rock, the distance on it from stream to stream being upwards of a mile.

Salt.

Attempts have been made to obtain salt by boring wells at various points on the North and Middle Forks, but the abandonment of them all shows a lack of financial success. This is probably chiefly due to conditions independent of the supply obtained, among others the small market accessible, but for a few of them it must be attributed to weak and insufficient brine. Possibly deeper borings would have resulted better, as was found to be the case in Clay county. The more important of these wells are described in Dr. D. D. Owen's reports on the Survey for the years 1854 and 1855.

In the same report, pages 67 and 218, are described the salt wells of Clay county, which at that time were producing a considerable amount of salt. Only two of the wells are now in operation, competition with other supplies having cut off a large part of the former market. These two are situated at the forks of Goose creek, where the most abundant supply was found, and their combined production is said to be about 2,000 bushels of salt per year, one-tenth of the yield from about twelve wells in operation in the county thirty years ago. No sensible diminution in quantity or strength of brine is believed to have taken place in that time, the strength being said to remain constant at about ten degrees, while a slight reduction of quantity is attributed to leaks in pipes, which are not kept in good repair.

Gas.

The active interest in natural gas now awakened by its successful application to manufactures makes it worth while to repeat the description of the "Burning Spring" given in Dr. Owen's report, referred to above, page 217, which is as follows:

"The 'Burning Spring,' of Clay county, is one of the remarkable geological phenomena of this section of the country. Through a pool of water in a narrow bottom a constant stream of gas escapes in copious volumes. A lighted match suffices to set the gas on fire, which flashes instantaneously into numerous jets across the pool, continuing to burn until the force of the gas, or a gust of wind, blows it out. Judging from the color of the flame and the odor of the gas, it appears to be a mixture of heavy and light carburetted hydrogen, with some free or uncombined hydrogen.

"The commotion in the water rendered it too turbid, without filtration, to test it satisfactorily for its saline constituents. Bi-carbonate of iron seems to be the principal constituent.

"The gases must here reach the surface from some deep-seated source, through an extensive fissure of the rocks, concealed by the debris from the hills—perhaps from some bed of coal or iron ore exposed to surheated (superheated) steam or other heat, by which decomposition is effected with evolution of these gases. Whatever their origin may be, the materials which supply the elements must be contained in the interior of the earth on a vast scale, since the 'Burning Spring' has continued to evolve these gases with unremitting energy since the country was known to the first settlers. In half an hour during which I continued to watch its action, I could not perceive any cessation or intermission."

It is said that two of these springs are found on branches of Sexton's creek, one of which, on Sacker branch, was visited by the writer, and a cursory examination made. The above description is there applicable, no apparent change having taken place in the character or amount of gas escaping, after the lapse of thirty-odd years since the first recorded visit was made. The conglomerate rock crops out in the valley a short distance below the spring.

That no effective utilization of this wasted heat has been attempted is rather surprising. If not applicable for other purposes, it might easily be carried to the salt wells at the forks of Goose creek, about ten miles, and be economically used there in the evaporation of brine.

Silver Ore.

Considerable time and means having been spent in desultory and unavailing search for silver ore in various localities of this region, as well as elsewhere in this coal field, it is desirable to state that as yet no indication of any deposit of silver ore worth exploitation has ever been discovered in the Appalachian coal fields; and also that no true vein of any kind has been found in the eastern field of the State, excepting the one here described under the caption of iron ore. From these facts, after such investigation in this field as has been made, it may be assumed as reasonably certain that no paying quantity of silver ever will be found in it, though it is beyond dispute that occasional silver-bearing ore has been found in exceedingly small quantities. The rugged conglomerate cliffs, which have attracted the most search, are not more likely to contain silver than other smoother surfaces.

The legends of Swift and his concealed silver mines and treasures, current in the mountains from Pennsylvania to Georgia and North Carolina, may be left to those who wish to believe them. It should be known, however, that the North American Indians had no knowledge of mining or metallurgy.

This report would be incomplete without acknowledgment of the faithful service, in the difficult work of exploration between the North and South Forks, Kentucky river, of Mr. James I. Profitt, through whose untiring zeal in searching for and opening coal outcrops such success as has been obtained in gathering information of the various coal beds is in a great measure due.

Apart from the subject in hand, but meriting record here for want of a place more suitable, the following description is added of a "pounding mill" in use on Lick branch, Red river, Clay county. This grist mill is probably the last of its kind in the State, the hand-mills and home-made four-bladed turbines cut from solid wooden blocks, and now in common use, having generally superseded them.

The mill consists essentially of a mortar and pestle; the mortar a short section of a tree, in one end of which a hole is scooped out for the reception of grain; the pestle a straight stick about four feet long, attached to one end of a lever supported in the middle.

A weight is hung with the pestle in order to balance the opposite end of the lever, which end has cut in it a hollow place with a capacity of about half a barrel.

Water is led to this trough from the rapidly-falling stream by a conduit some 100 feet long, made of the bark of trees five or six inches in diameter.

When the trough is filled with water the added weight causes it to descend, until its inclination is sufficient for most of the water to run out. The greatest weight being then on the other end the pestle falls, and lifts the trough into position to be refilled.

This see-saw motion continued, it is said, will crush into very nice meal a half bushel of corn left over night in the mortar; and also any stray field-mice, or other hungry, small animals which may venture into the mortar, left open and unprotected in the forest.

N'S

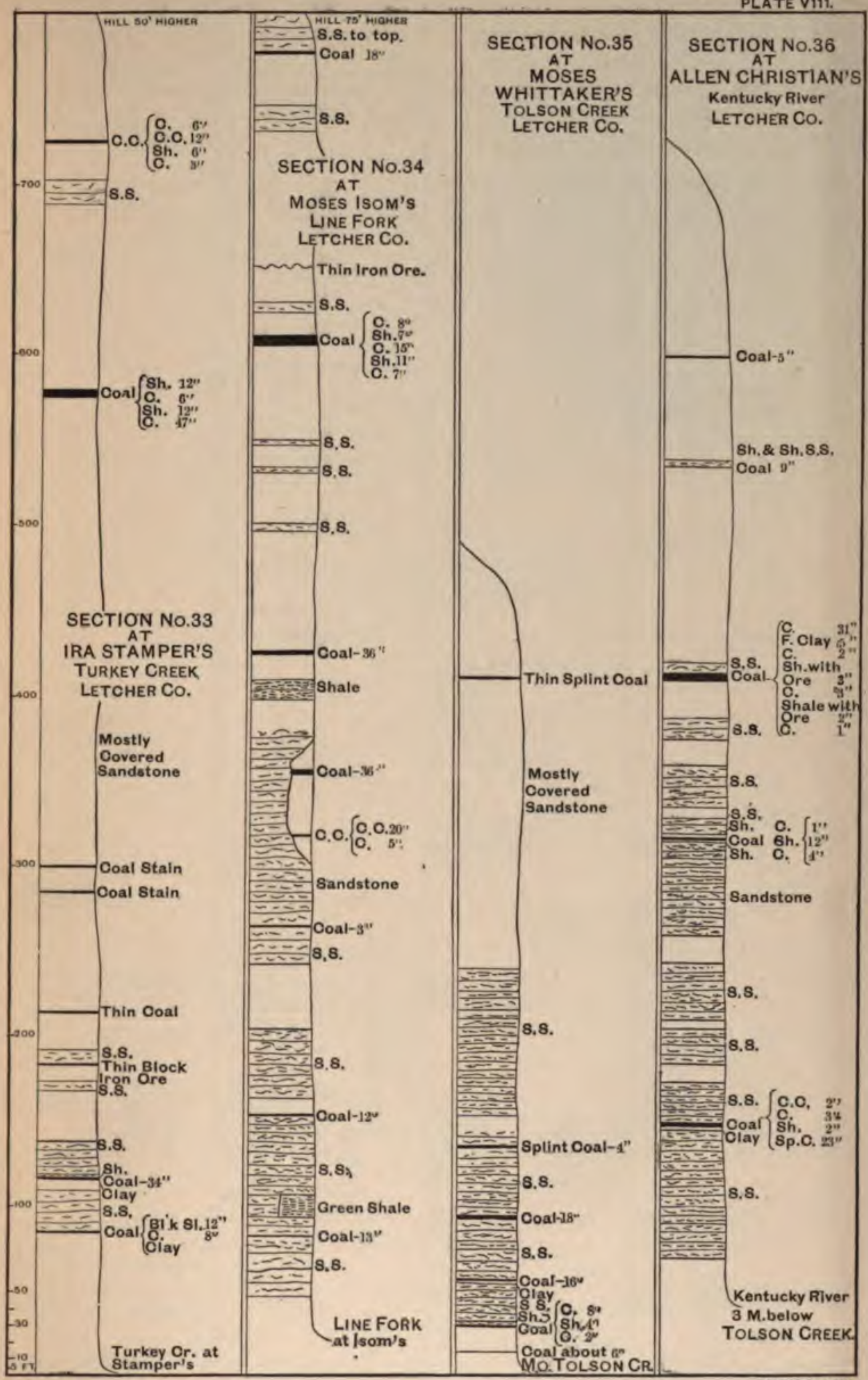
31"
th
with

ver

EK

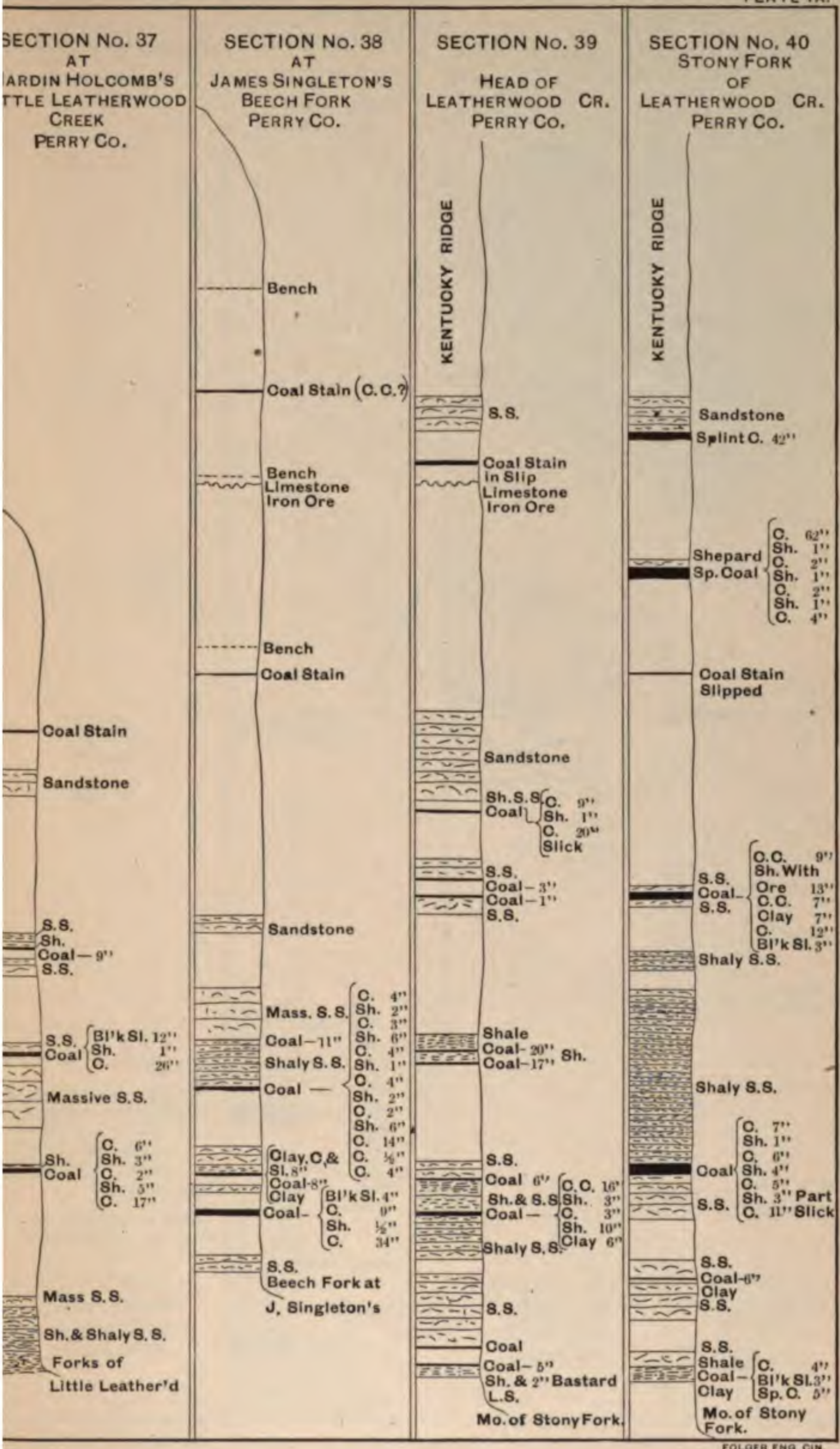
[illegible]

PLATE V111.



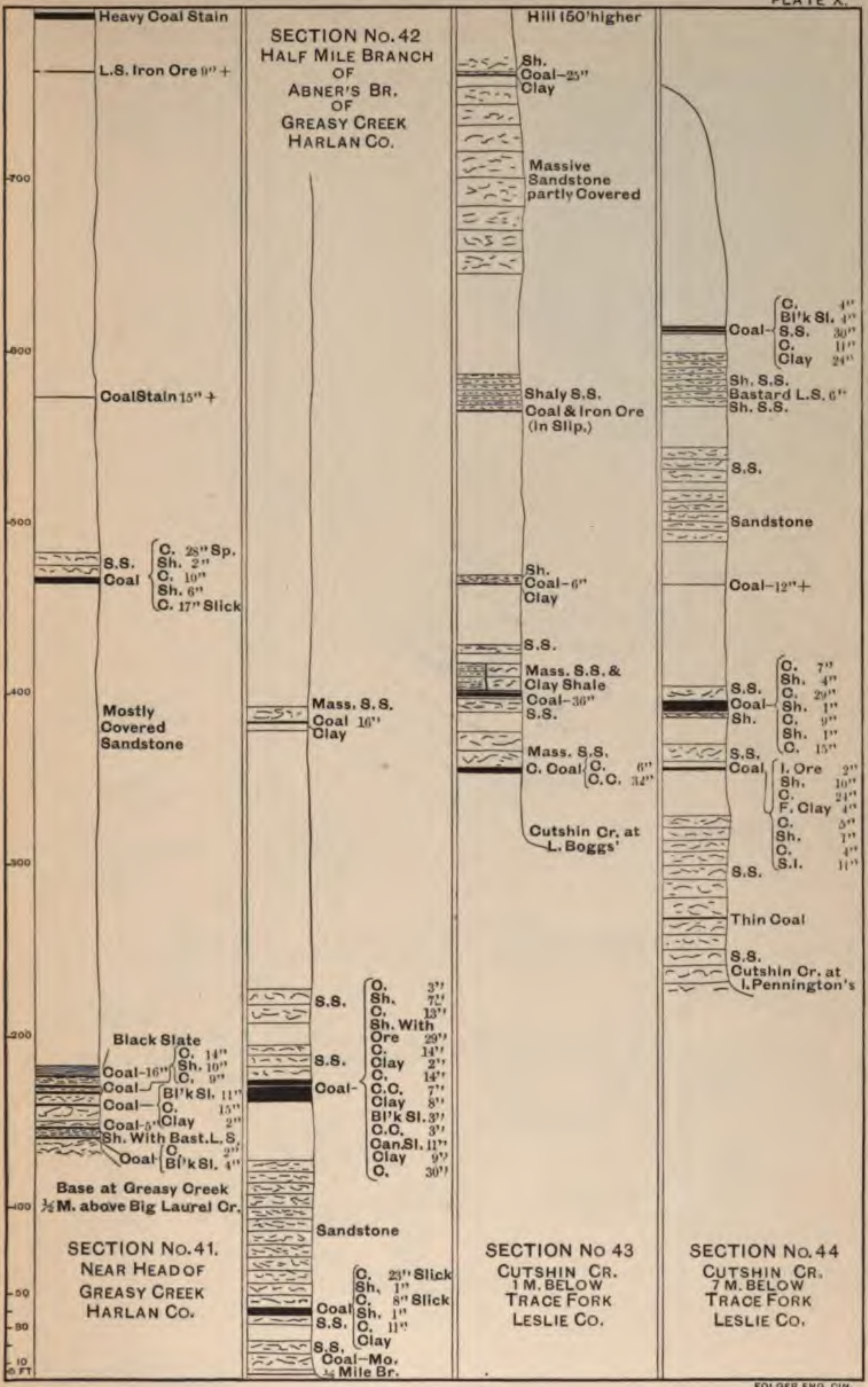
FOLGER ENG. CIN.

PLATE IX.



FOLGER ENG. CIN.

PLATE X.



SECTION No. 41.
NEAR HEAD OF
GREASY CREEK
HARLAN CO.

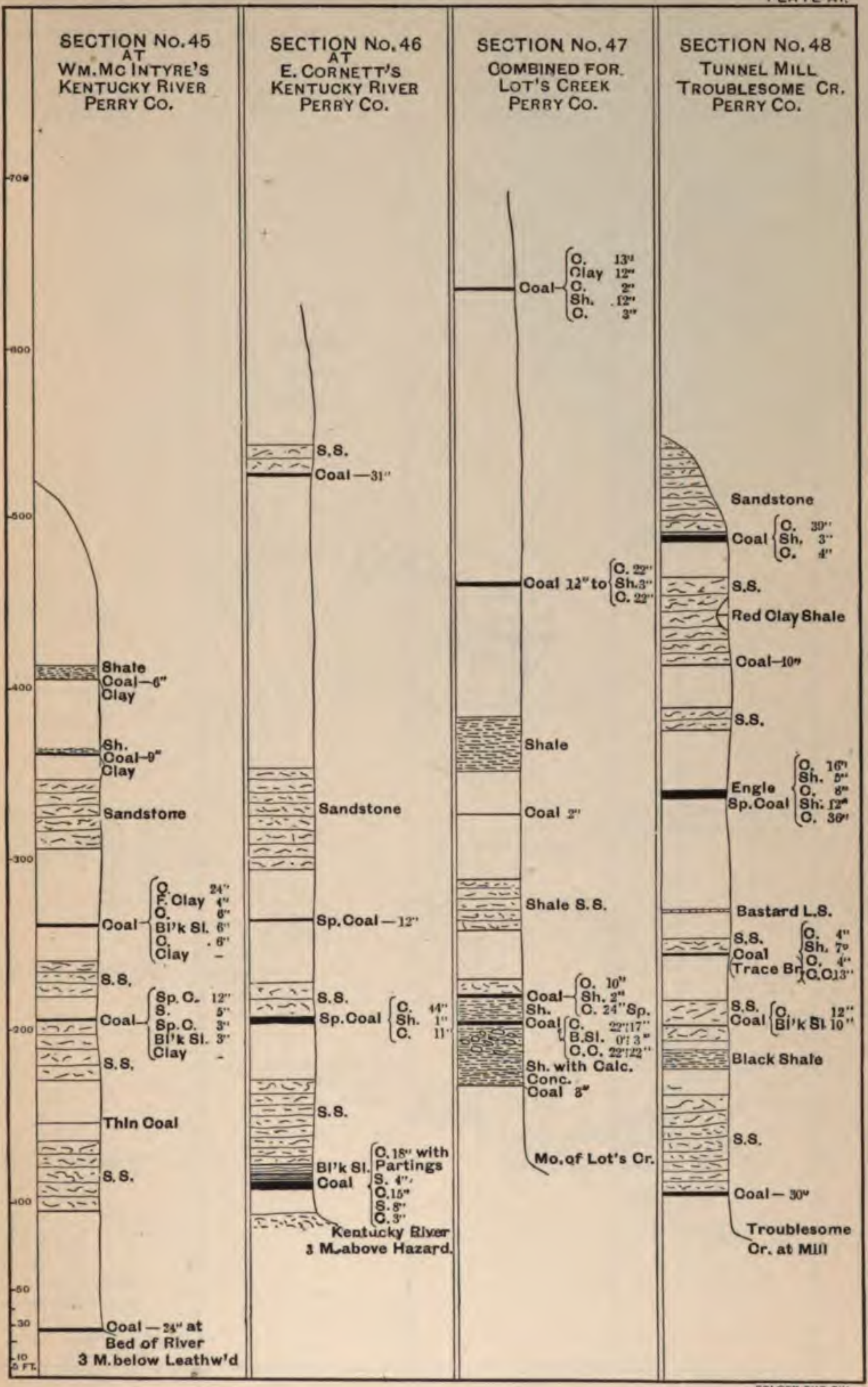
SECTION No. 42
HALF MILE BRANCH
OF
ABNER'S BR.
OF
GREASY CREEK
HARLAN CO.

SECTION No 43
CUTSHIN CR.
1 M. BELOW
TRACE FORK
LESLIE CO.

SECTION No. 44
CUTSHIN CR.
7 M. BELOW
TRACE FORK
LESLIE CO.

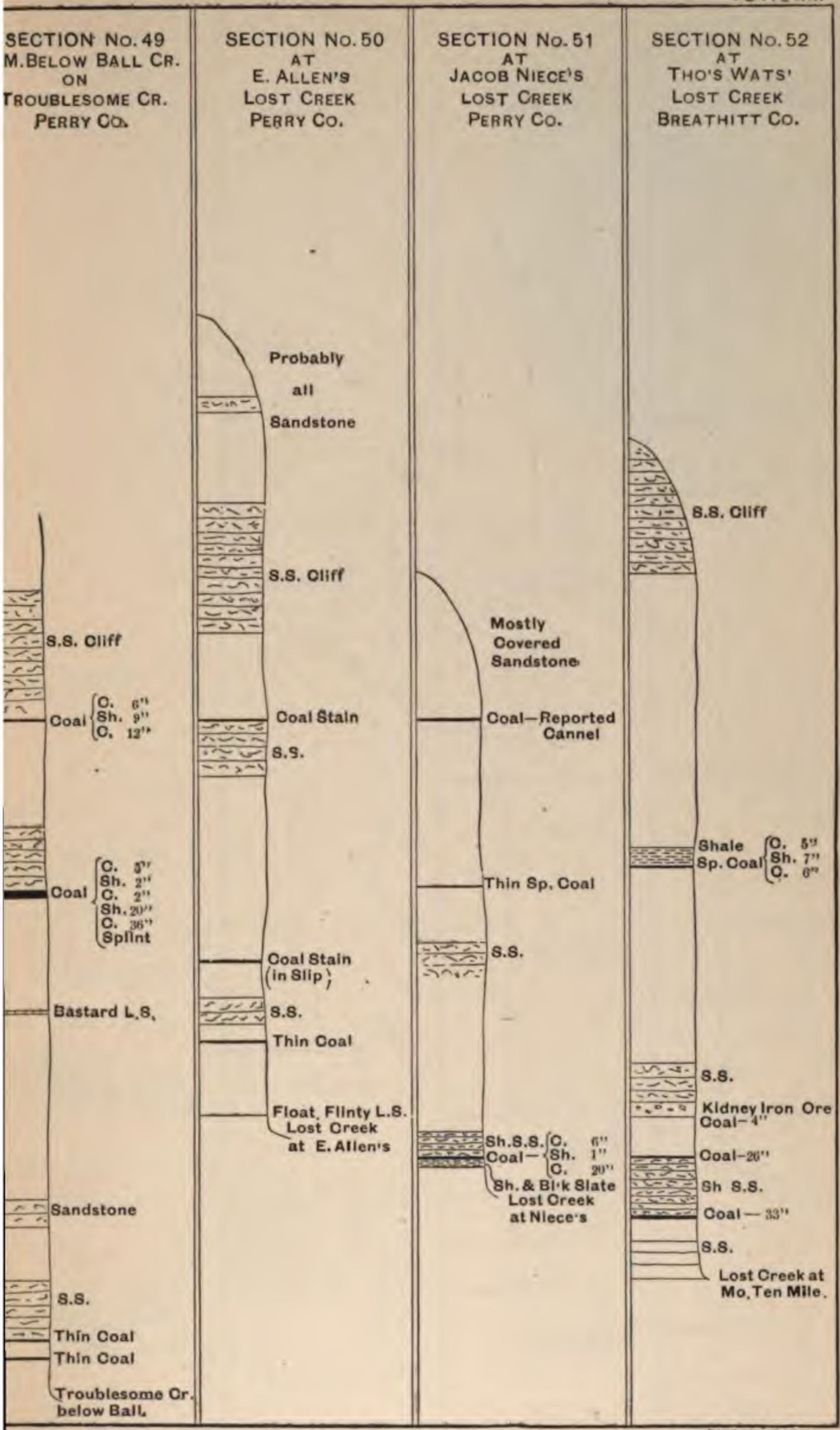
FOLGER ENG. CIN.

PLATE XI.



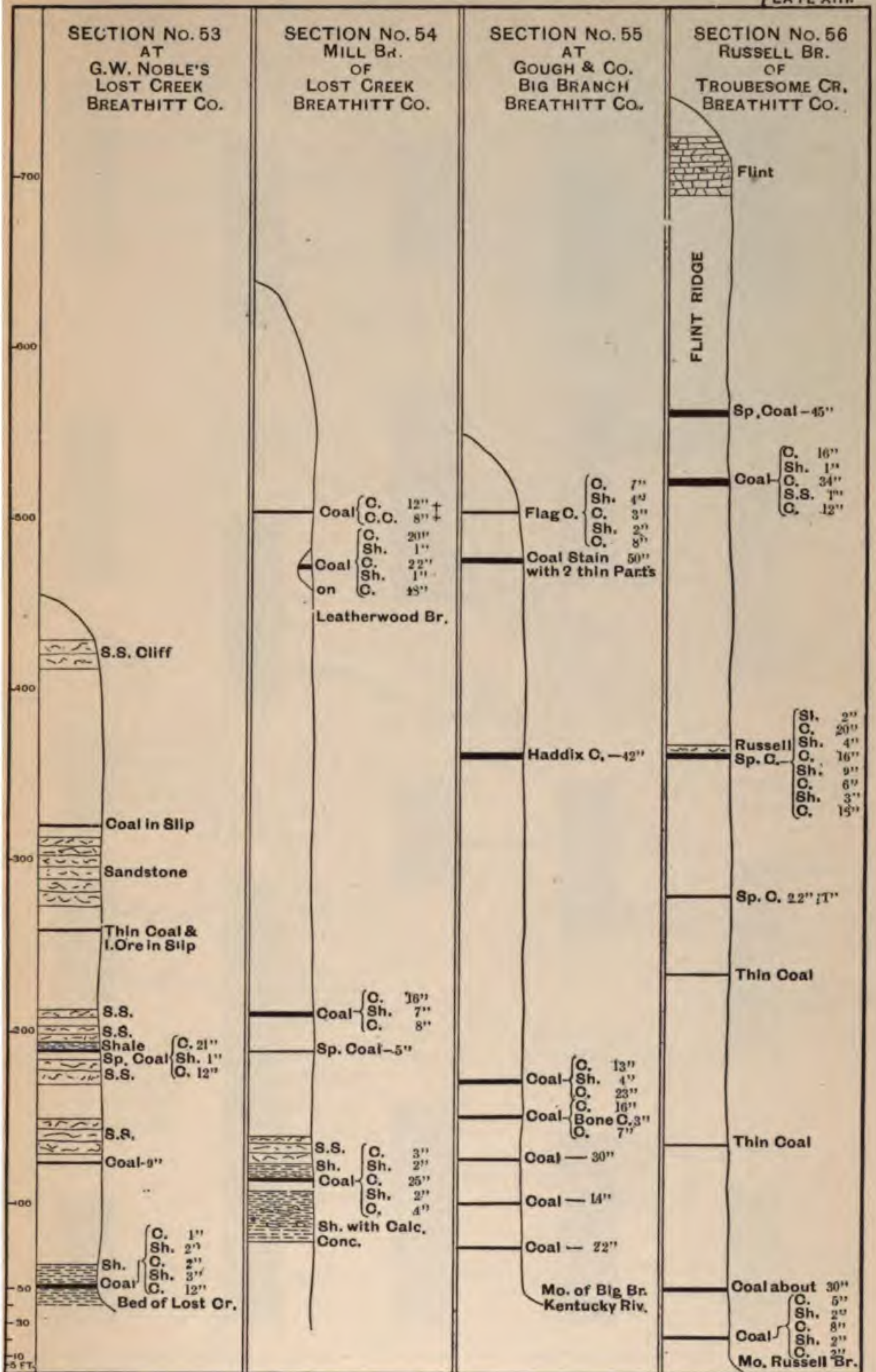
FOLGER ENG. CIN.

PLATE XII.



FOLGER ENG. CIN.

PLATE XIII.


SECTION No. 53 AT G.W. NOBLE'S LOST CREEK BREATHITT CO.
SECTION No. 54 MILL BR. OF LOST CREEK BREATHITT CO.
SECTION No. 55 AT GOUGH & CO. BIG BRANCH BREATHITT CO.
SECTION No. 56 RUSSELL BR. OF TROUBESOME CR. BREATHITT CO.
700
600
500
400
300
200
100
50
30
10
5 FT.
S.S. Cliff
Coal in Slip
Sandstone
Thin Coal & I.Ore in Slip
S.S.
S.S.
Shale
Sp. Coal { C. 21" Sh. 1" C. 12"
S.S.
S.S.
Coal-9"
Sh.
Coal { C. 1" Sh. 2" C. 2" Sh. 3" C. 12"
Bed of Lost Cr.
Coal { C. 12" ‡ C.C. 8" ‡
Coal on { C. 20" Sh. 1" C. 22" Sh. 1" C. 18"
Leatherwood Br.
Coal { C. 16" Sh. 7" C. 8"
Sp. Coal–5"
S.S.
Sh.
Coal { C. 3" Sh. 2" C. 25" Sh. 2" C. 4"
Sh. with Calc. Conc.
Flag C. { C. 7" Sh. 4" C. 3" Sh. 2" C. 8"
Coal Stain 50" with 2 thin Parts
Haddix C. –42"
Coal { C. 13" Sh. 4" C. 23"
Coal { C. 16" Bone C. 3" C. 7"
Coal — 30"
Coal — 14"
Coal — 22"
Mo. of Big Br. Kentucky Riv.
Flint
FLINT RIDGE
Sp. Coal –45"
Coal { C. 16" Sh. 1" C. 34" S.S. 1" C. 12"
Russell Sp. C. { Sl. 2" C. 20" Sh. 4" C. 16" Sh. 9" C. 6" Sh. 3" C. 15"
Sp. C. 22" 1T"
Thin Coal
Thin Coal
Coal about 30"
Coal { C. 5" Sh. 2" C. 8" Sh. 2" C. 2"
Mo. Russell Br.

FOLGER ENG. CIN.

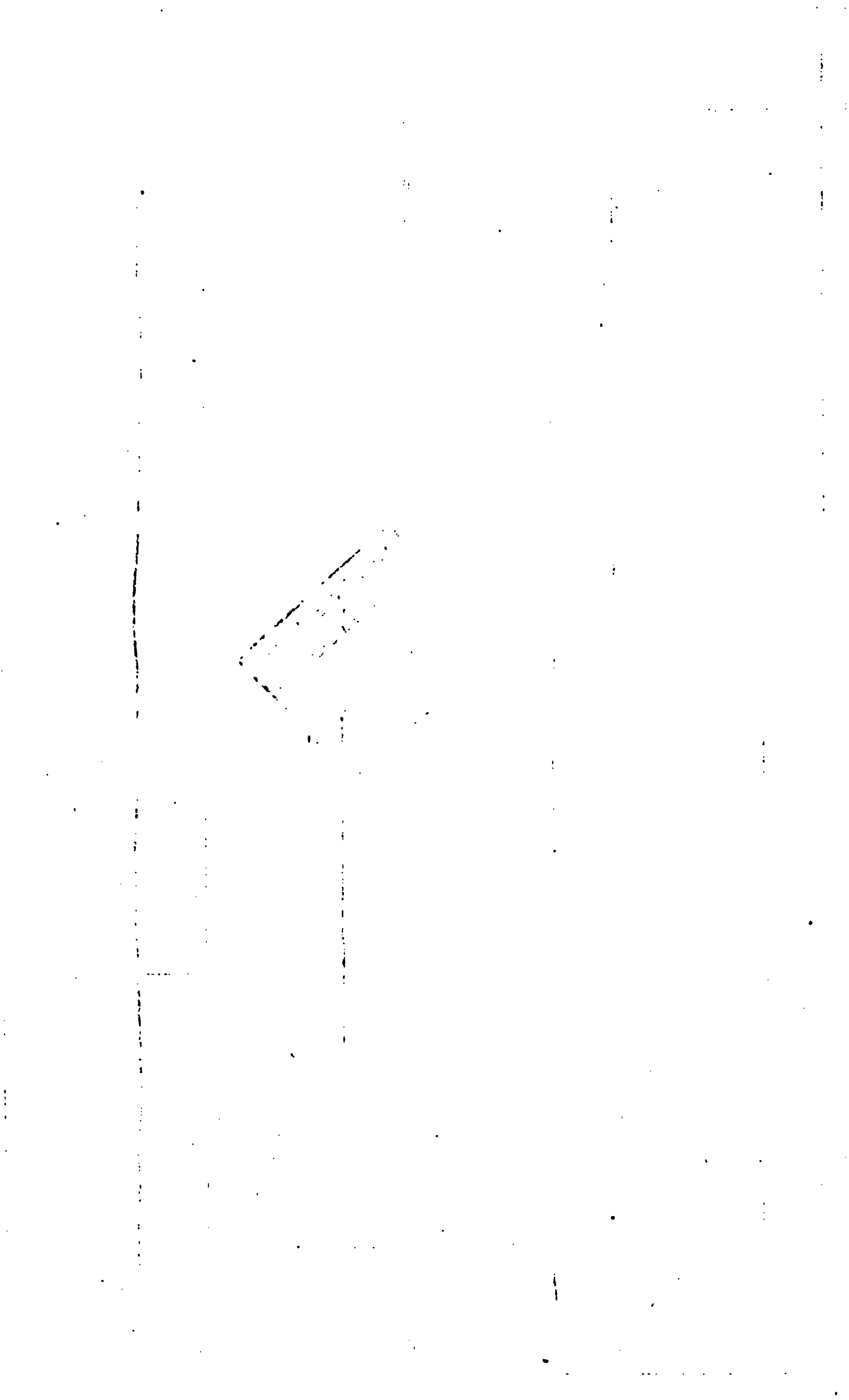
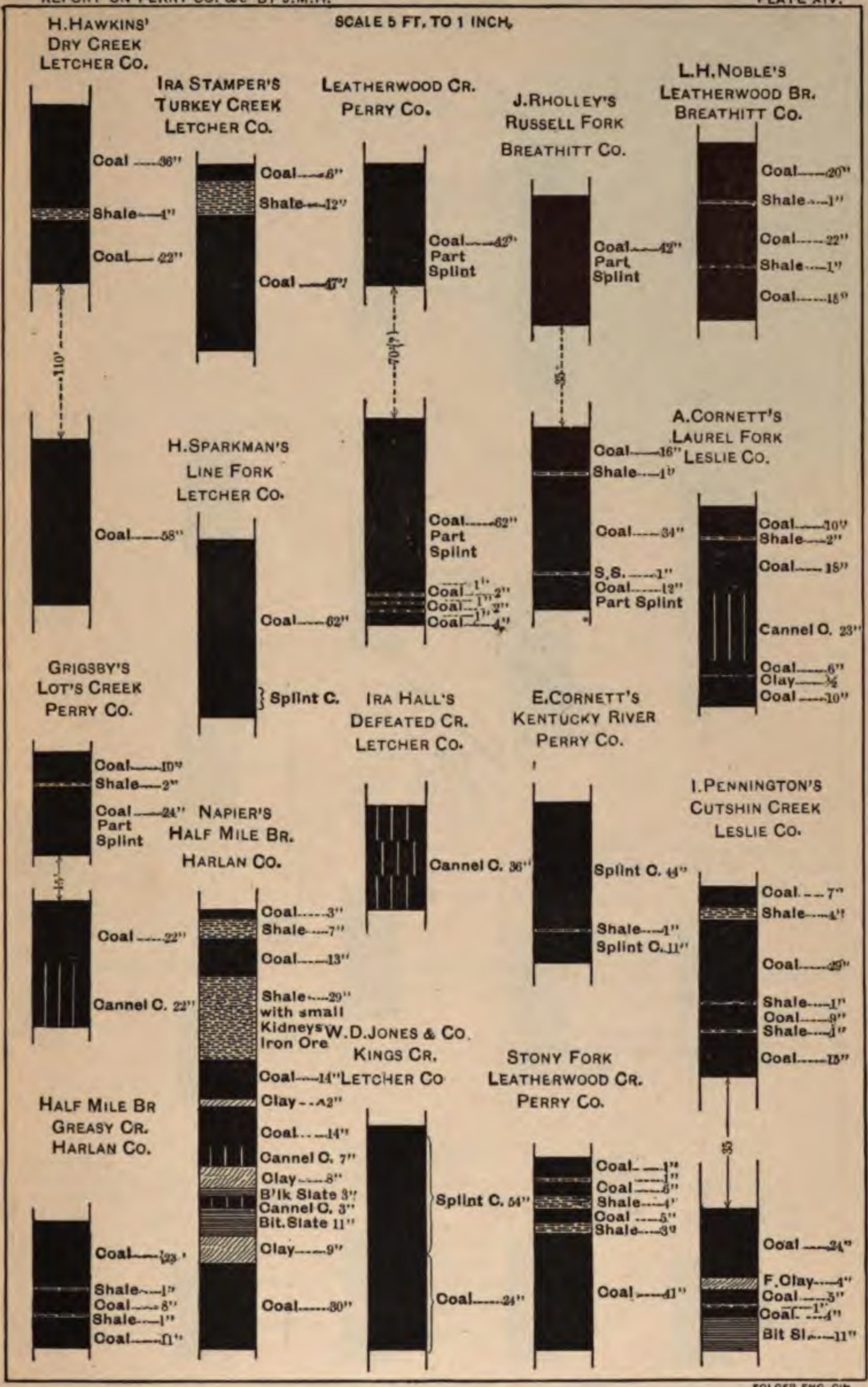
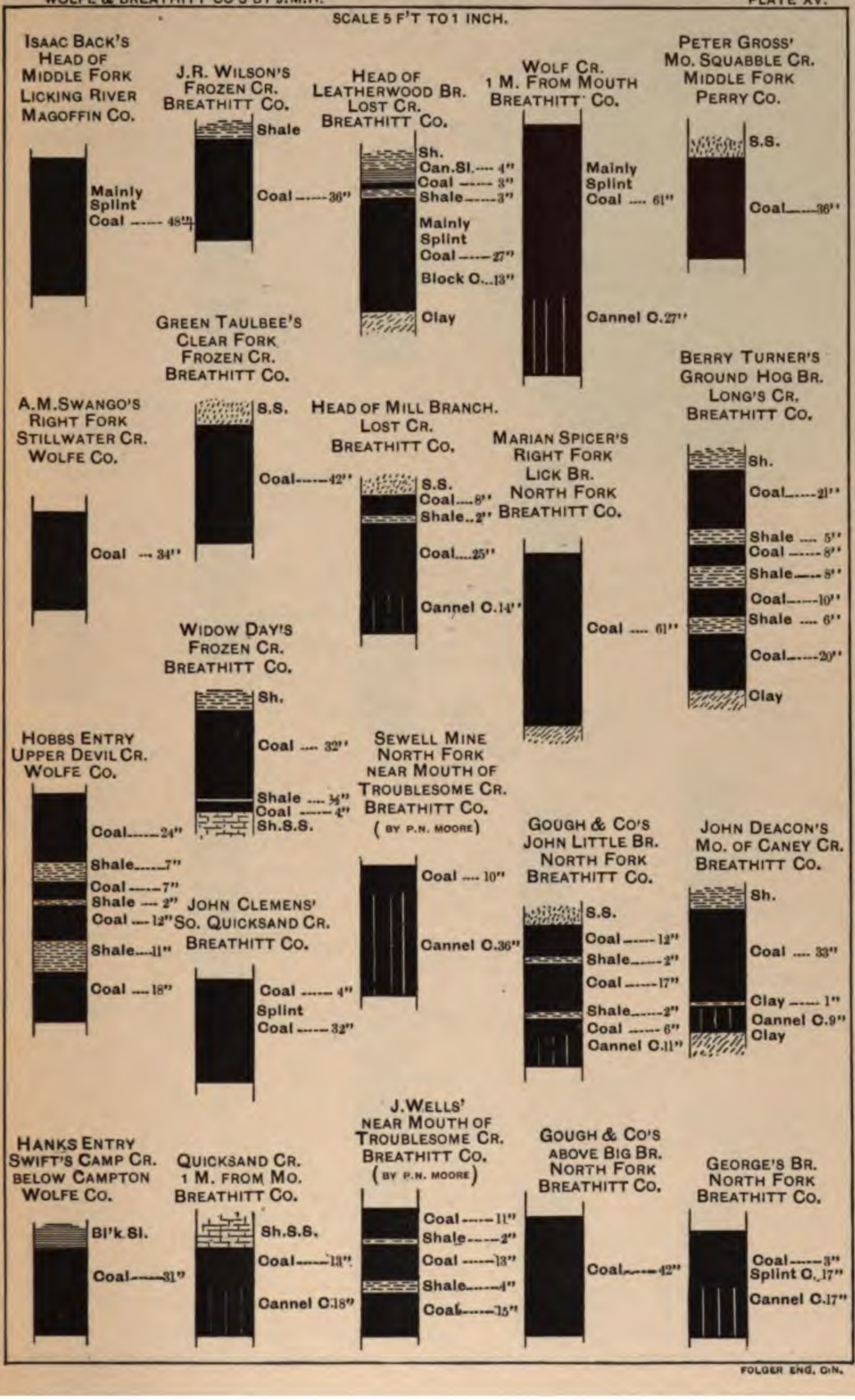


PLATE XIV.

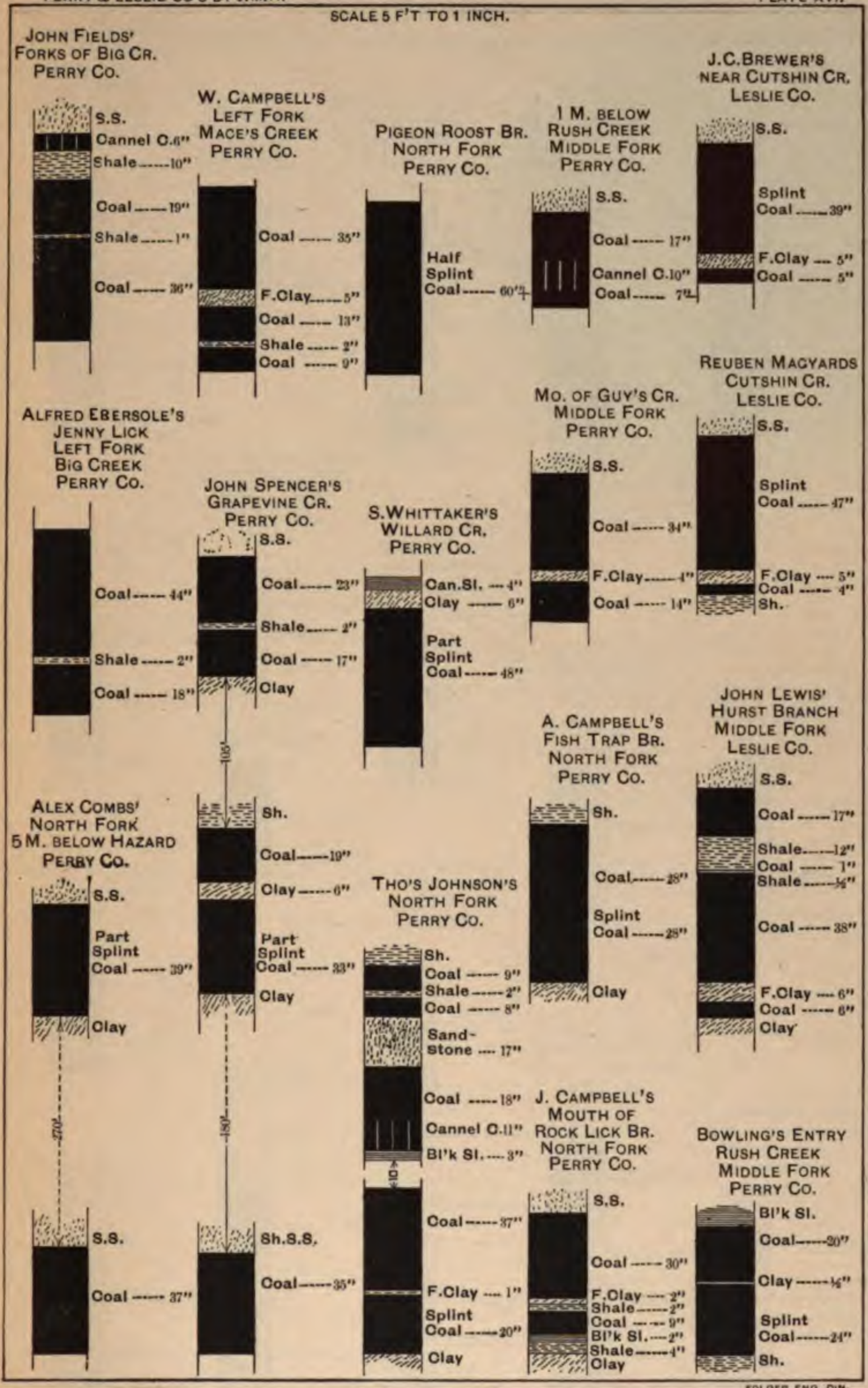


FOLGER ENG. CIN.

WOLFE & BREATHITT CO'S BY J.M.H. PLATE XV.

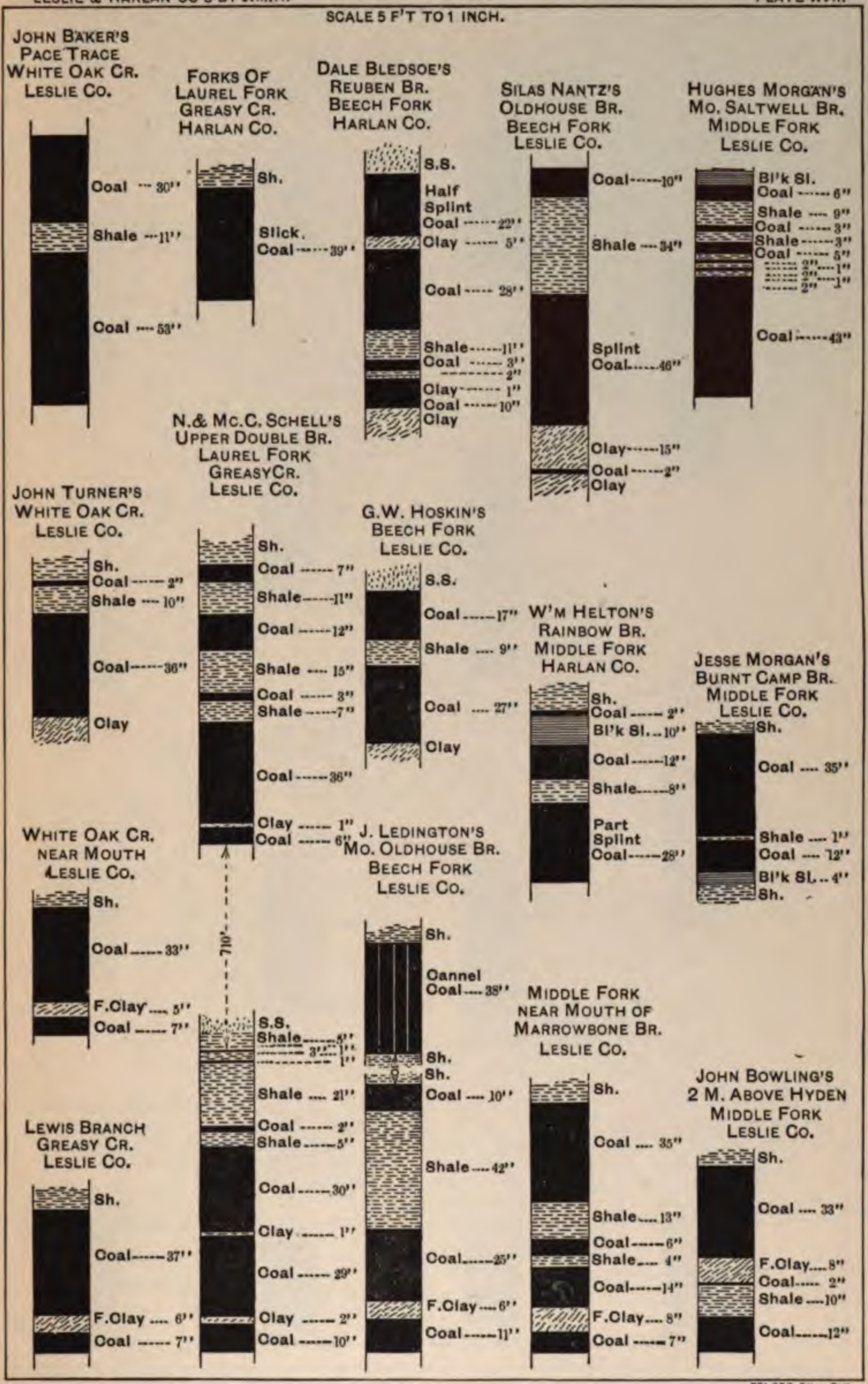

SCALE 5 F'T TO 1 INCH.
ISAAC BACK'S HEAD OF MIDDLE FORK LICKING RIVER MAGOFFIN CO.
Mainly Splint Coal ------ 48"
J.R. WILSON'S FROZEN CR. BREATHITT CO.
Shale
Coal ------ 36"
HEAD OF LEATHERWOOD BR. LOST CR. BREATHITT CO.
Sh.
Can.Sl. ---- 4"
Coal ------ 3"
Shale ------ 3"
Mainly Splint Coal ----- 27"
Block C... 13"
Clay
WOLF CR. 1 M. FROM MOUTH BREATHITT CO.
Mainly Splint Coal .... 61"
Cannel C. 27"
PETER GROSS' MO. SQUABBLE CR. MIDDLE FORK PERRY CO.
S.S.
Coal ----- 36"
GREEN TAULBEE'S CLEAR FORK FROZEN CR. BREATHITT CO.
S.S.
Coal ----- 42"
A.M.SWANGO'S RIGHT FORK STILLWATER CR. WOLFE CO.
Coal --- 34"
HEAD OF MILL BRANCH. LOST CR. BREATHITT CO.
S.S.
Coal .... 8"
Shale .. 2"
Coal .... 25"
Cannel C. 14"
MARIAN SPICER'S RIGHT FORK LICK BR. NORTH FORK BREATHITT CO.
Coal .... 61"
BERRY TURNER'S GROUND HOG BR. LONG'S CR. BREATHITT CO.
Sh.
Coal ----- 21"
Shale .... 5"
Coal ----- 8"
Shale ---- 8"
Coal ----- 10"
Shale .... 6"
Coal ----- 20"
Clay
WIDOW DAY'S FROZEN CR. BREATHITT CO.
Sh.
Coal .... 32"
Shale .... ½"
Coal ----- 4"
Sh.S.S.
HOBBS ENTRY UPPER DEVIL CR. WOLFE CO.
Coal ----- 24"
Shale ----- 7"
Coal ----- 7"
Shale --- 2"
Coal --- 12"
Shale --- 11"
Coal --- 18"
JOHN CLEMENS' SO. QUICKSAND CR. BREATHITT CO.
Coal ----- 4"
Splint Coal ----- 32"
SEWELL MINE NORTH FORK NEAR MOUTH OF TROUBLESOME CR. BREATHITT CO. (BY P.N. MOORE)
Coal .... 10"
Cannel C. 36"
GOUGH & CO'S JOHN LITTLE BR. NORTH FORK BREATHITT CO.
S.S.
Coal ----- 12"
Shale ----- 2"
Coal ----- 17"
Shale ----- 2"
Coal ----- 6"
Cannel C. 11"
JOHN DEACON'S MO. OF CANEY CR. BREATHITT CO.
Sh.
Coal .... 33"
Clay ----- 1"
Cannel C. 9"
Clay
HANKS ENTRY SWIFT'S CAMP CR. BELOW CAMPTON WOLFE CO.
Bl'k Sl.
Coal ----- 31"
QUICKSAND CR. 1 M. FROM MO. BREATHITT CO.
Sh.S.S.
Coal ----- 13"
Cannel C. 18"
J.WELLS' NEAR MOUTH OF TROUBLESOME CR. BREATHITT CO. (BY P.N. MOORE)
Coal ----- 11"
Shale ----- 2"
Coal ----- 13"
Shale ----- 4"
Coal ----- 15"
GOUGH & CO'S ABOVE BIG BR. NORTH FORK BREATHITT CO.
Coal ----- 42"
GEORGE'S BR. NORTH FORK BREATHITT CO.
Coal ----- 3"
Splint C. 17"
Cannel C. 17"

FOLGER ENG. CIN.



FOLGER ENG. CIN.

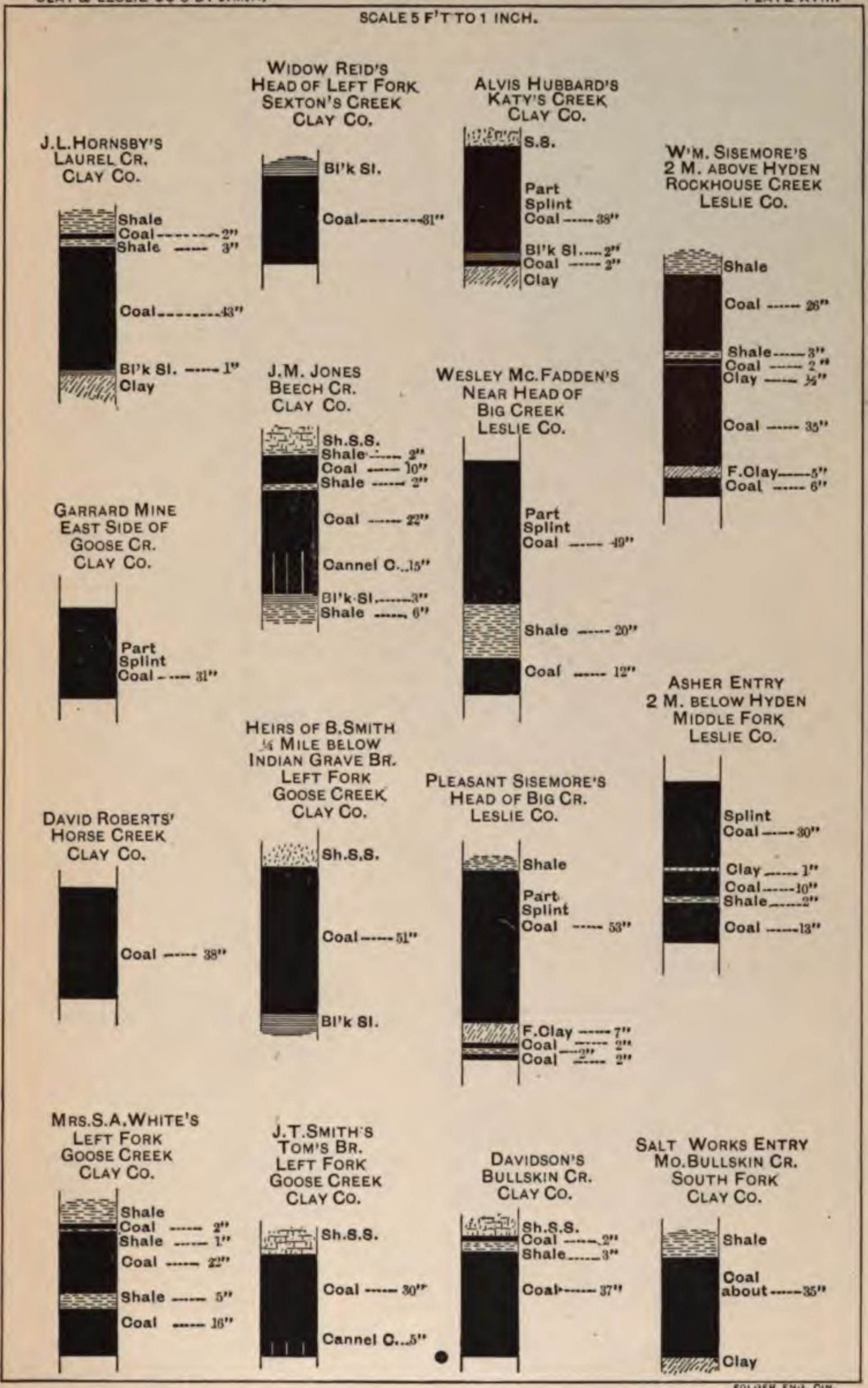
LESLIE & HARLAN CO'S BY J.M.H. PLATE XVII.


SCALE 5 F'T TO 1 INCH.

FOLGER ENG., CIN.

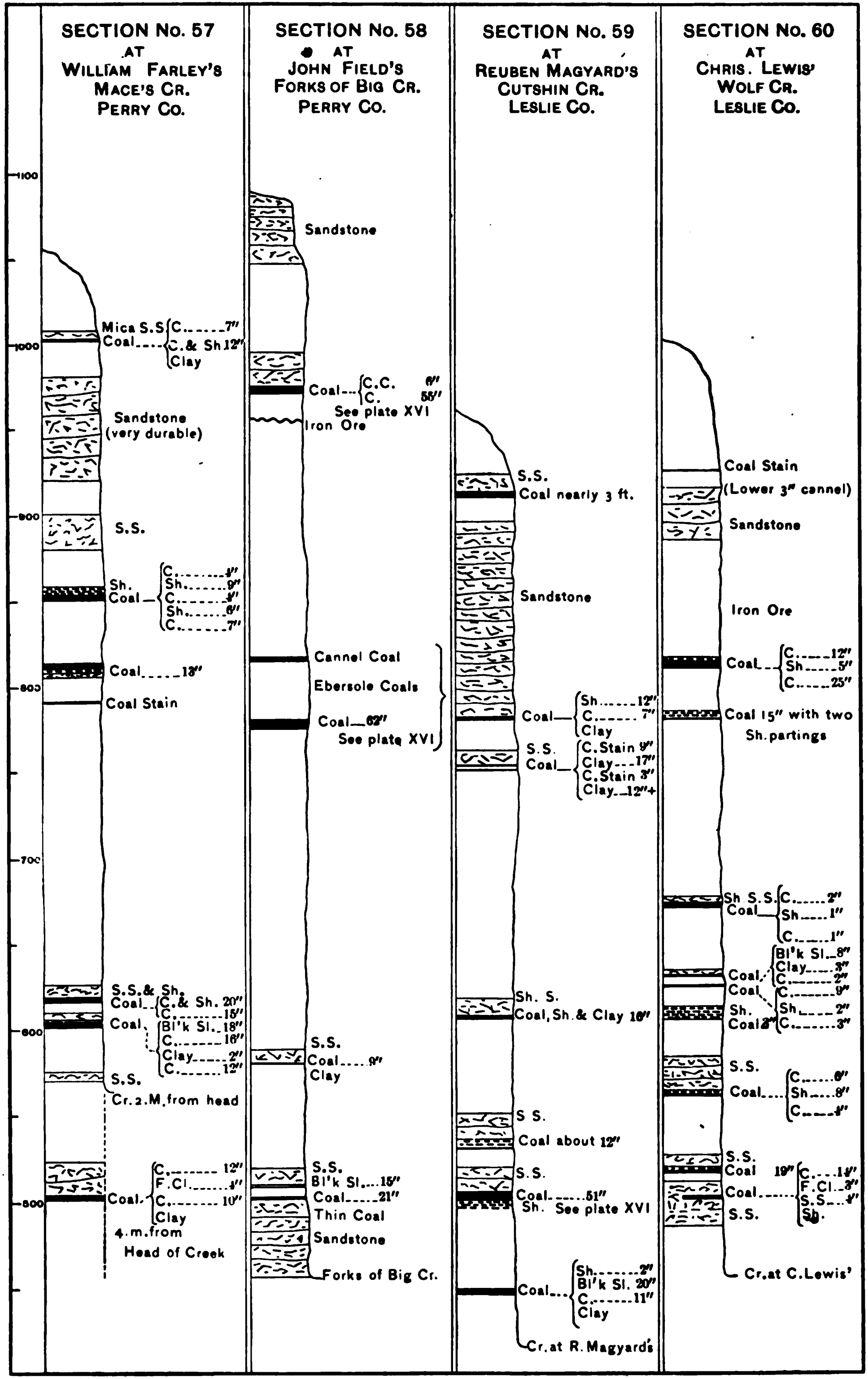
CLAY & LESLIE CO'S BY J.M.H.

PLATE XVIII.

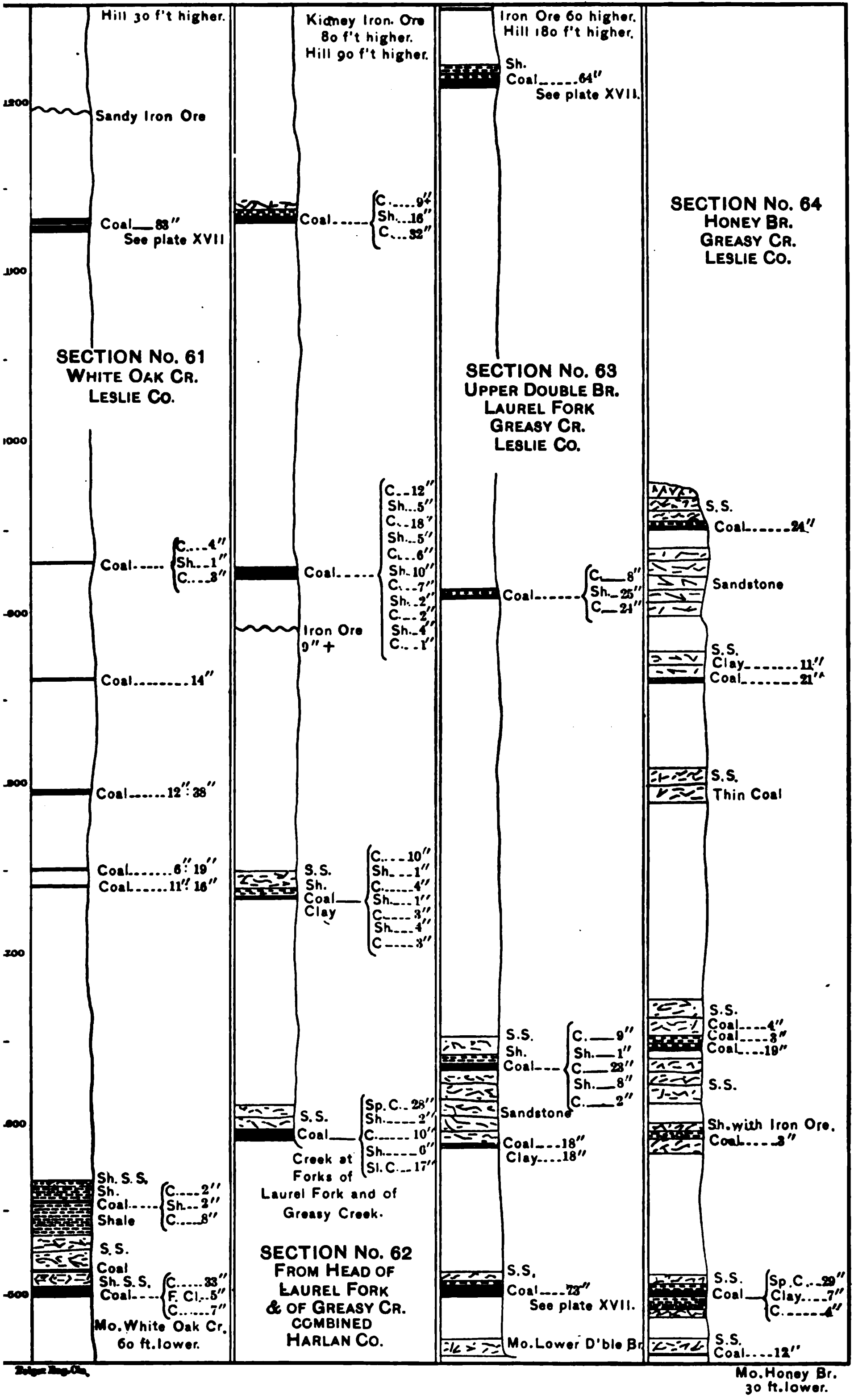


FOLGER ENG. CIN.

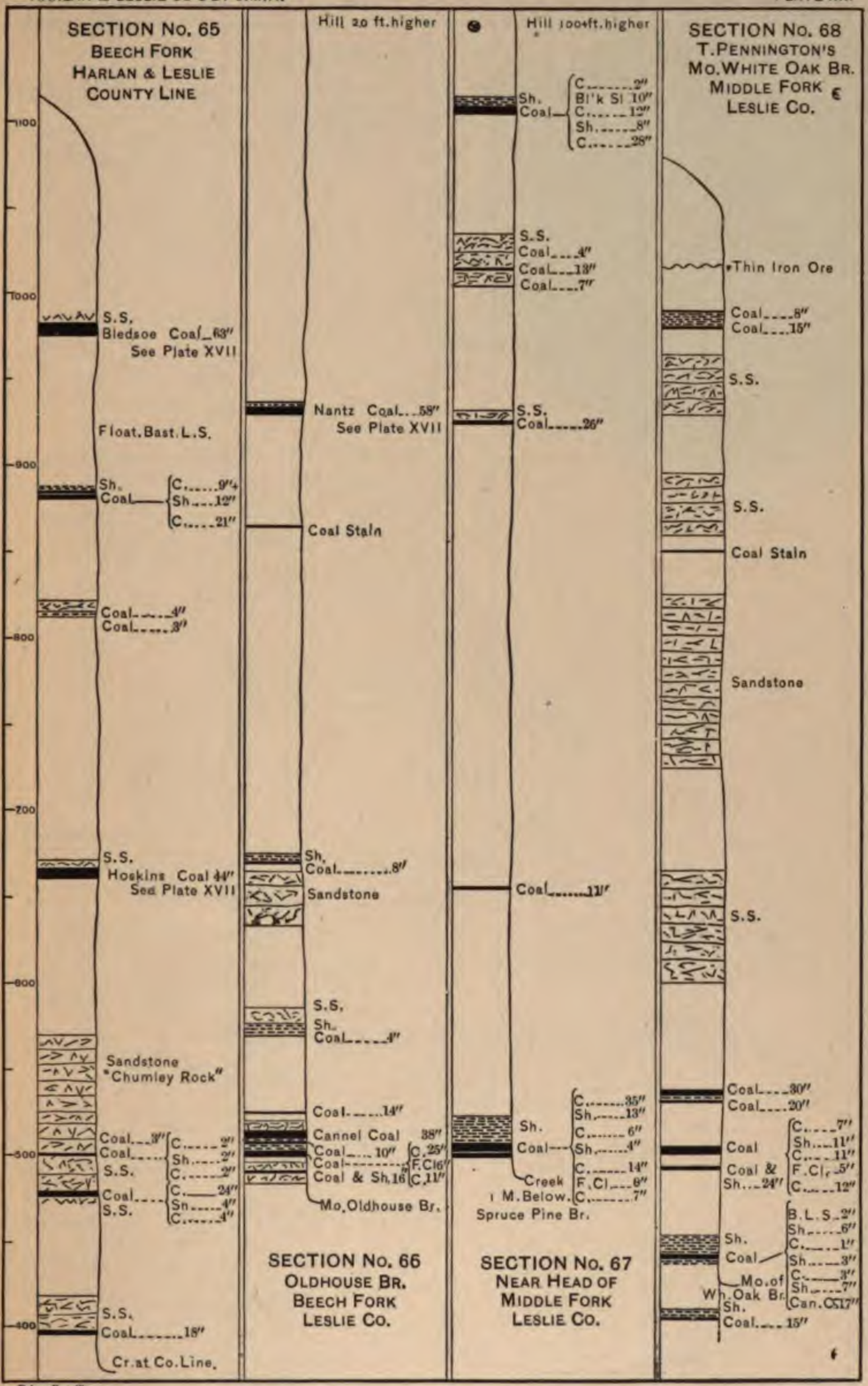
PERRY & LESLIE CO'S BY J.M.H. PLATE XIX



Folger Eng. Co.

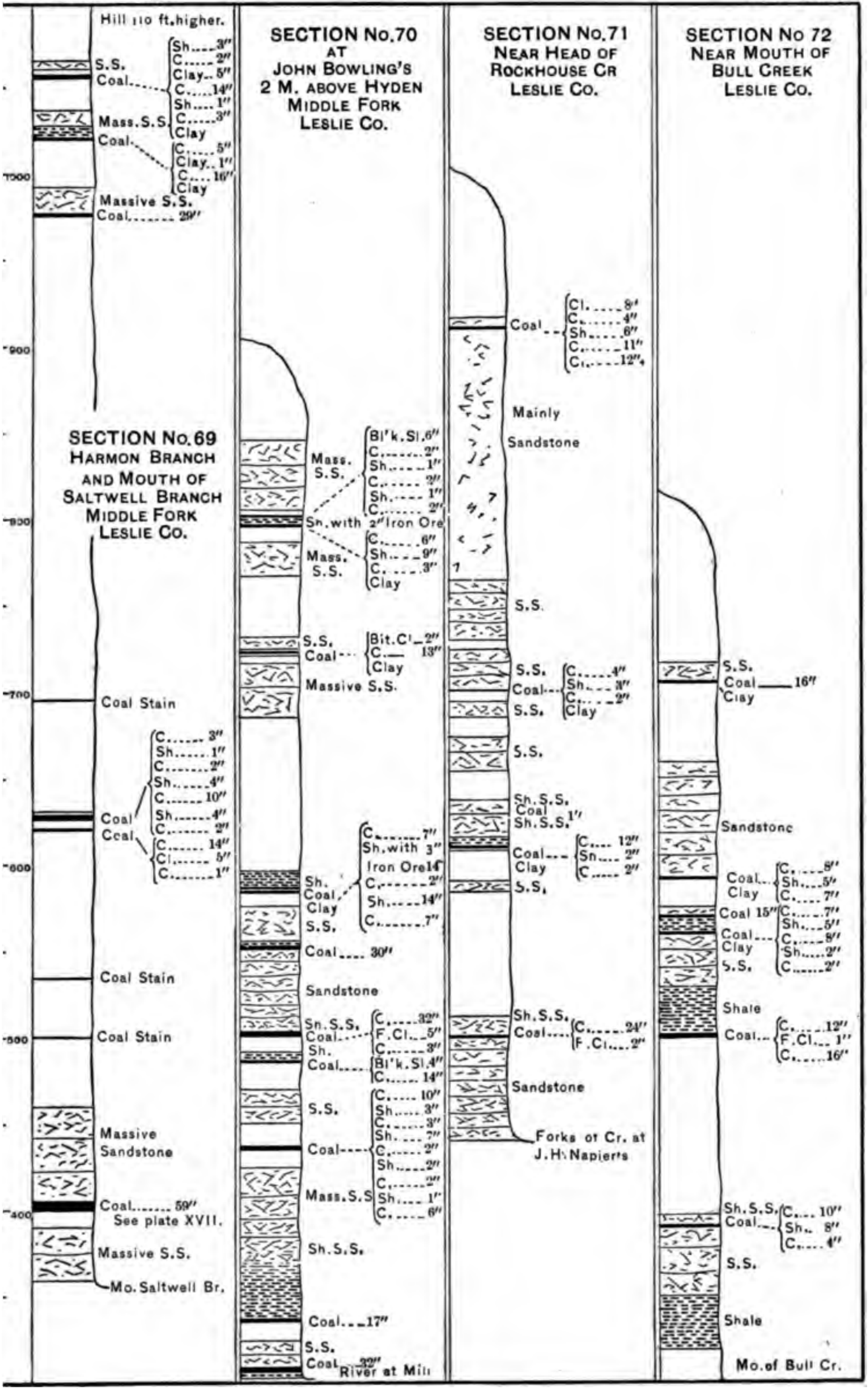


Bolger Eng. Co.



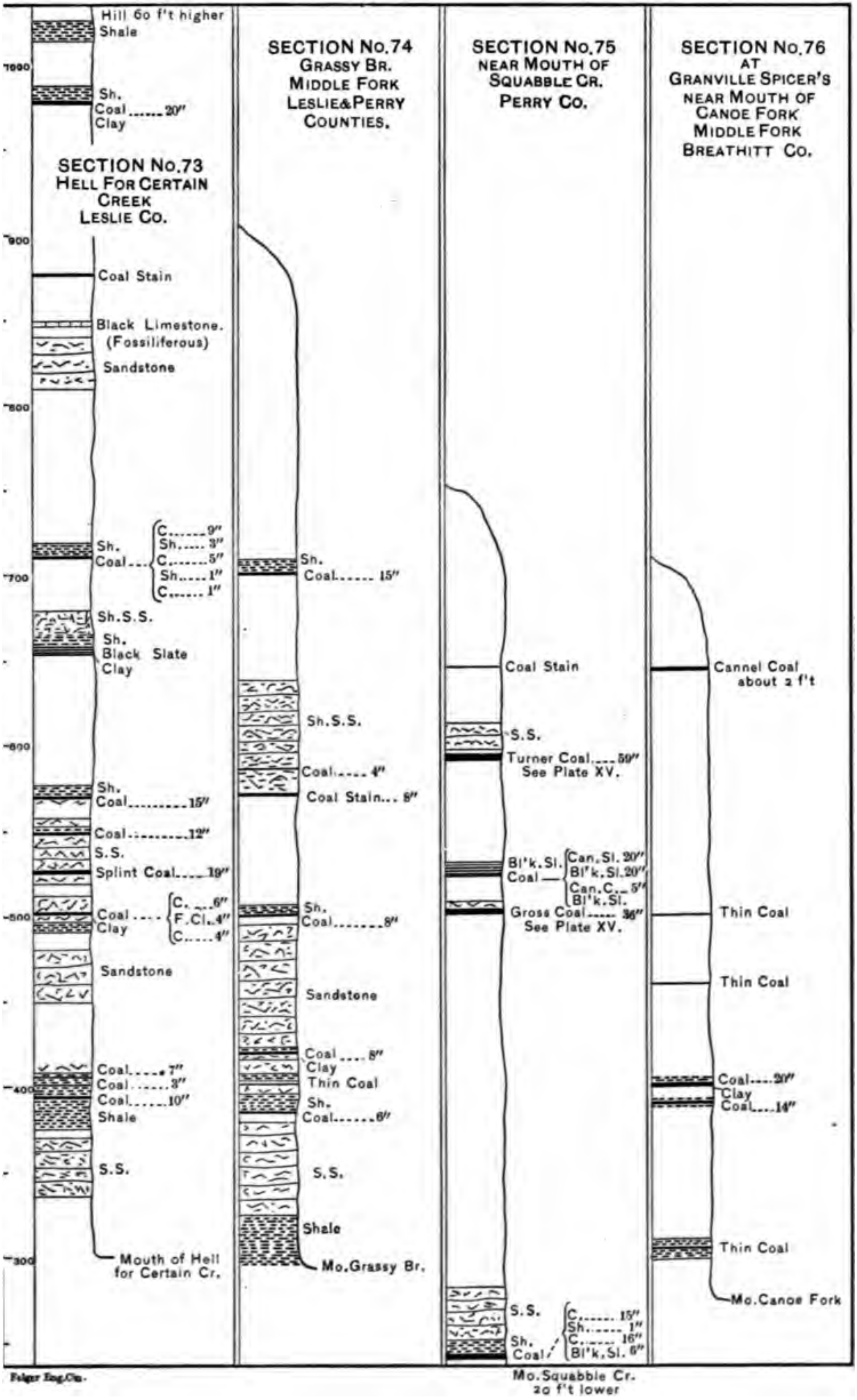
Folger Eng. Co.

LESLIE CO. BY J.M.H. PLATE XXII.



Folger Eng. Co.

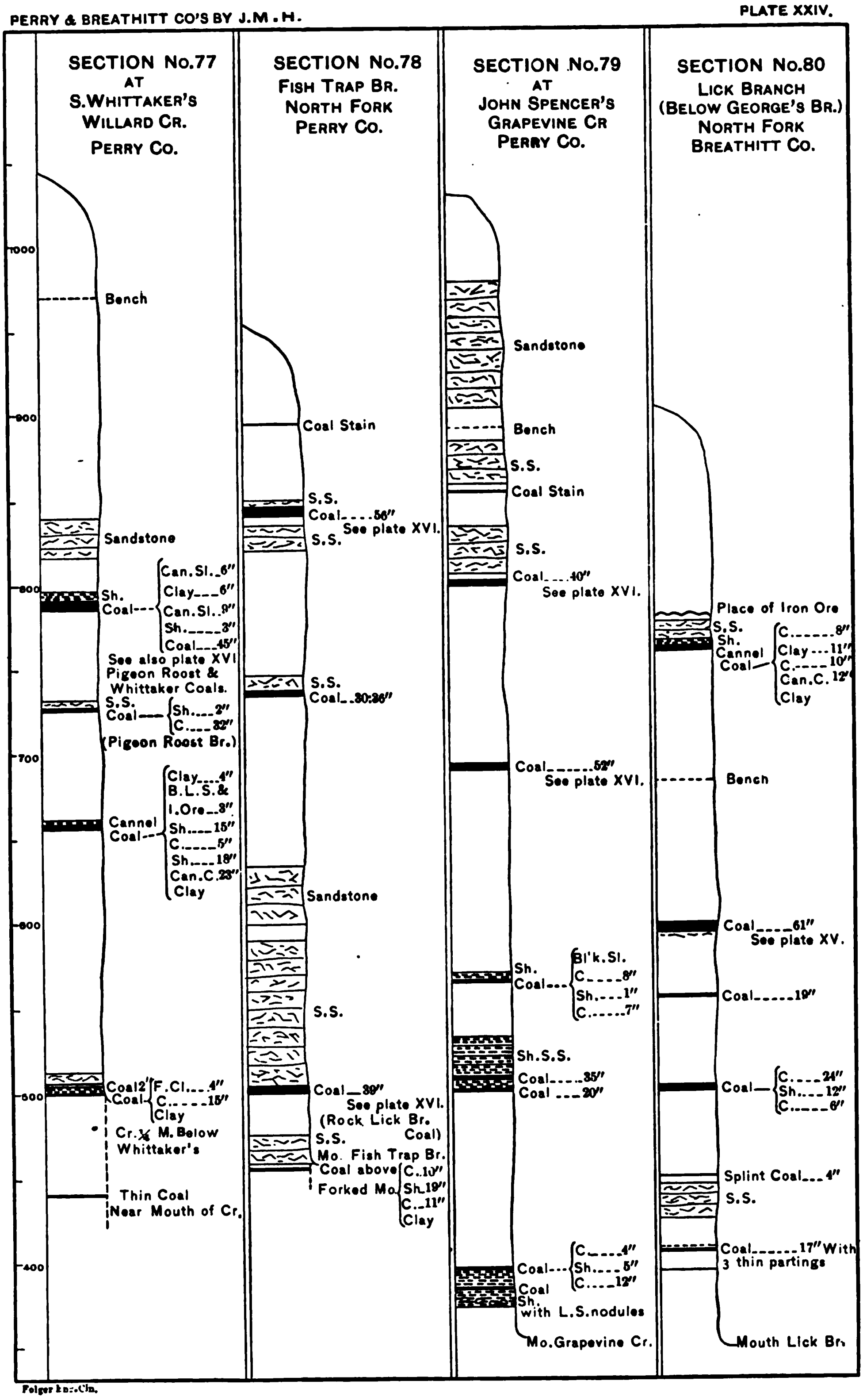
LESLIE, PERRY & BREATHITT CO'S BY J.M.H. PLATE XXIII.



Folger Eng. Co.

PERRY & BREATHITT CO'S BY J.M.H.

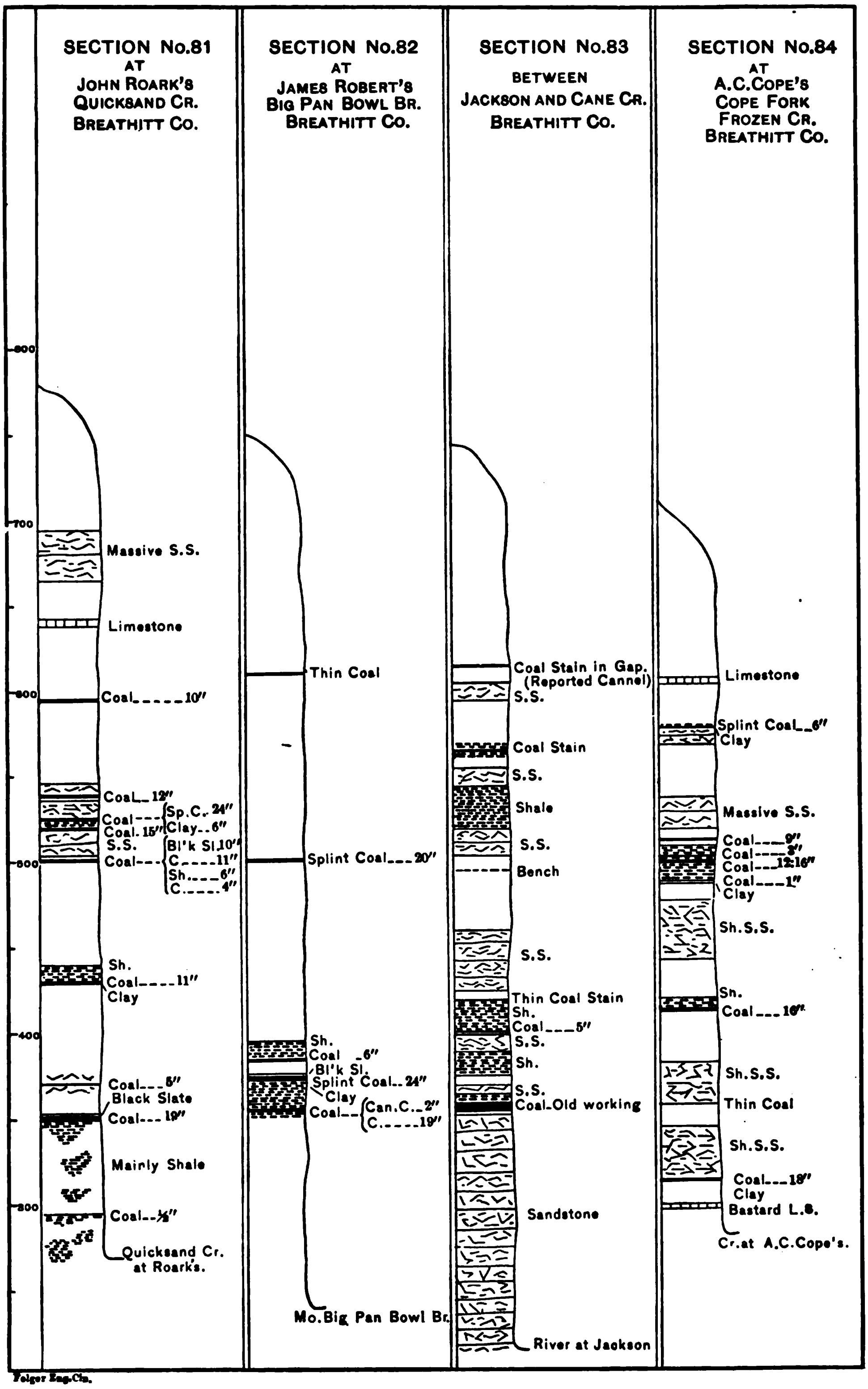
PLATE XXIV.



Folger Eng. Cin.

BREATHITT CO. BY J.M.H.

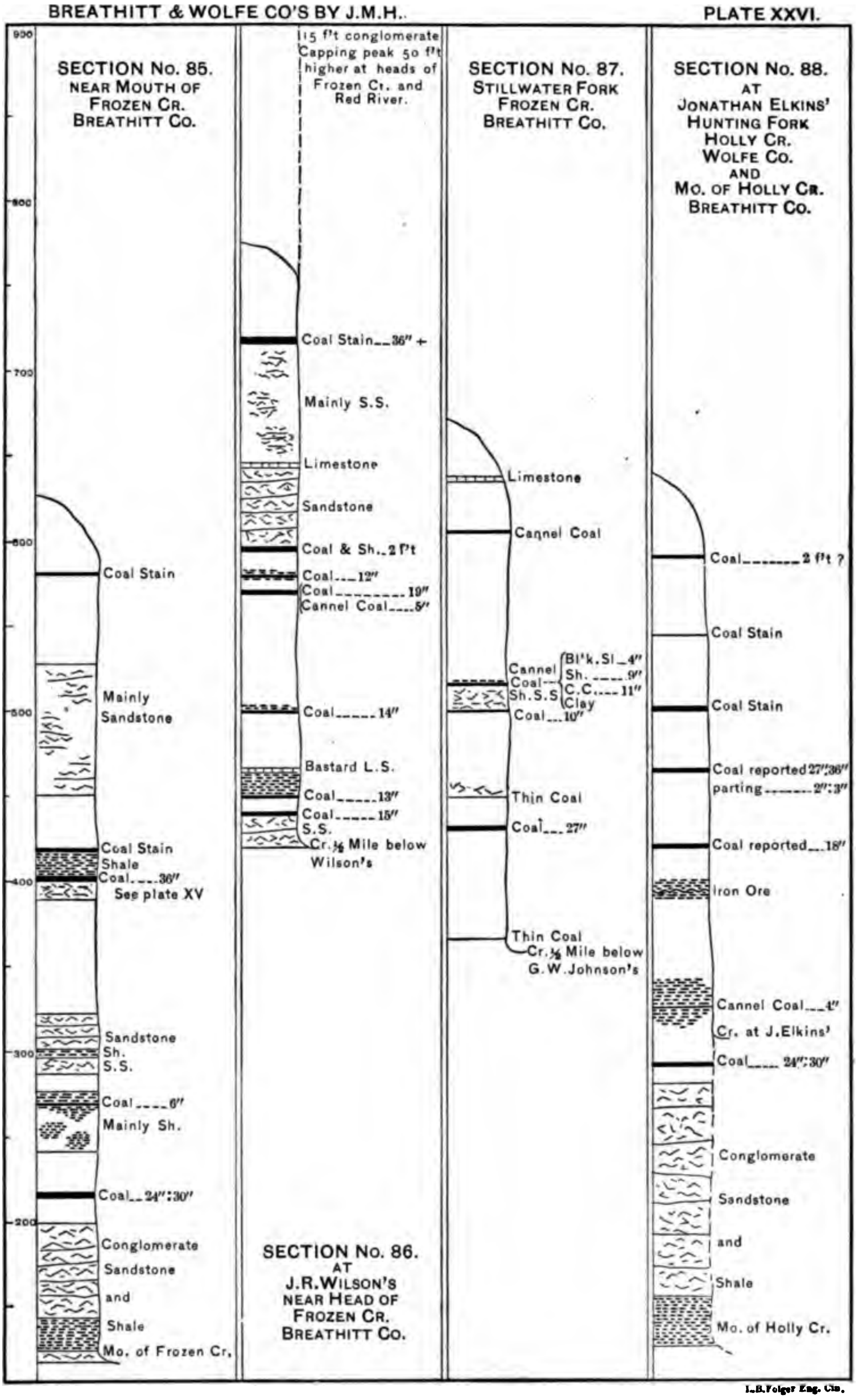
PLATE XXV.



Folger Eng.Co.

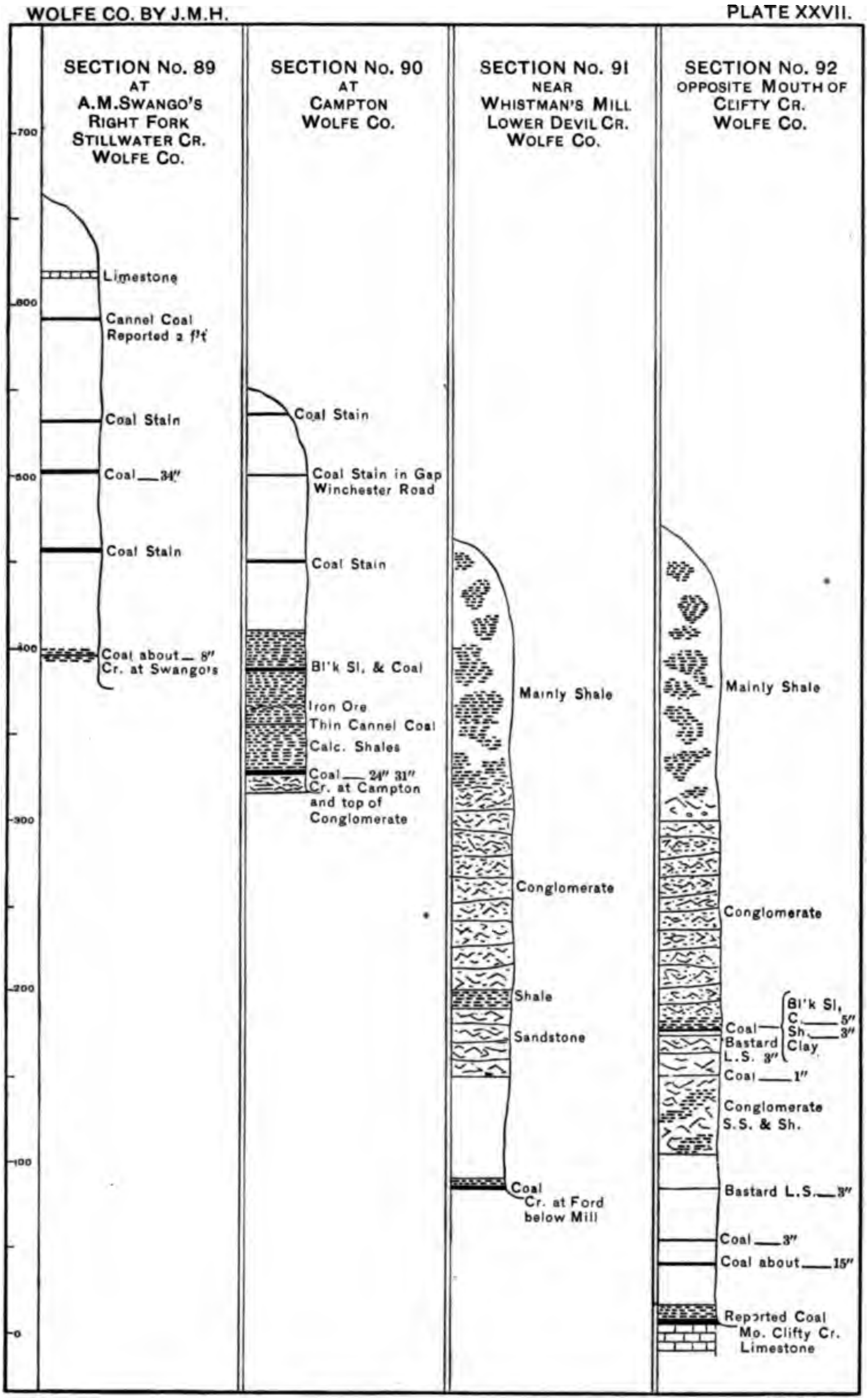
BREATHITT & WOLFE CO'S BY J.M.H.

PLATE XXVI.



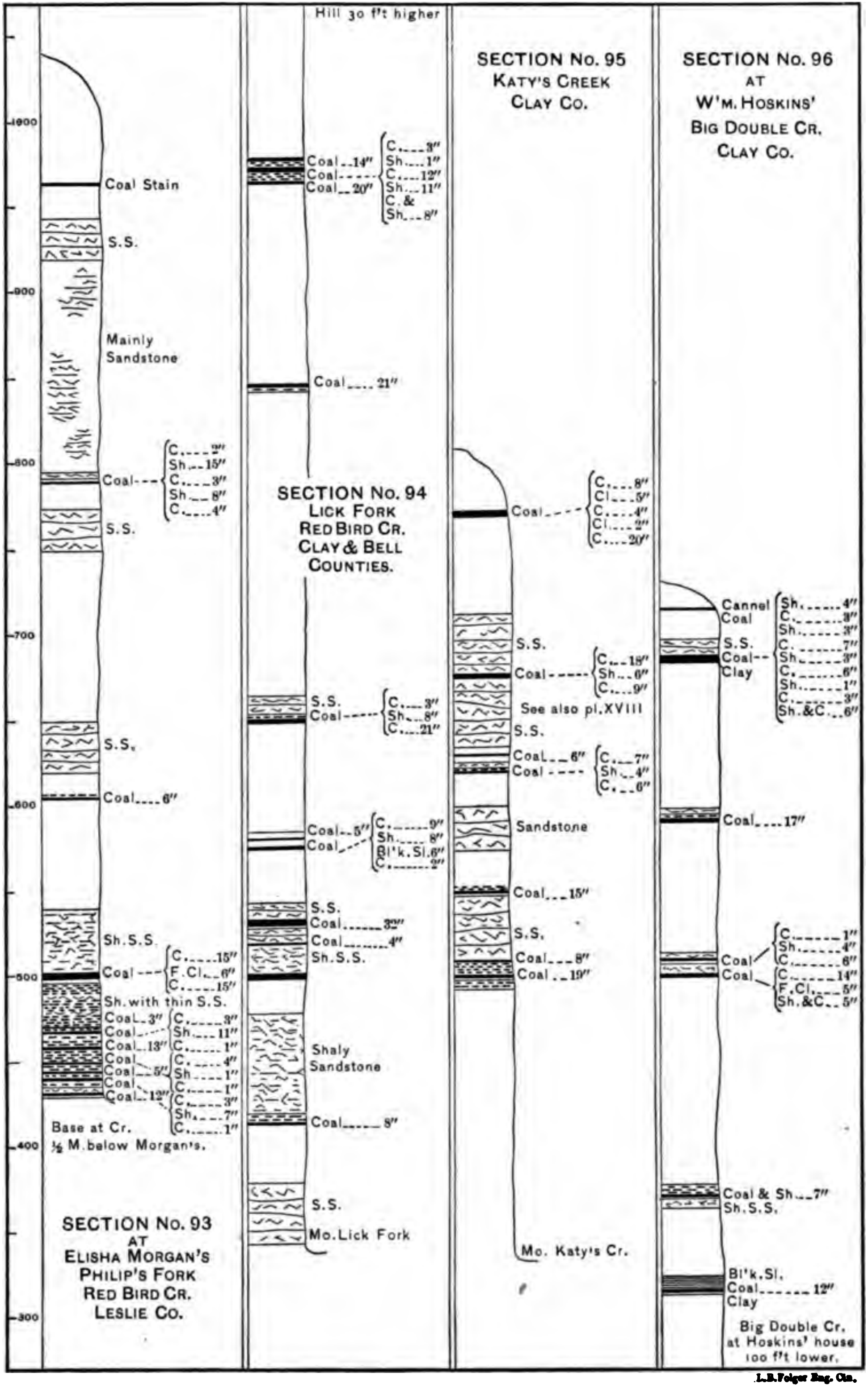
L.B.Folger Eng. Co.

WOLFE CO. BY J.M.H. PLATE XXVII.

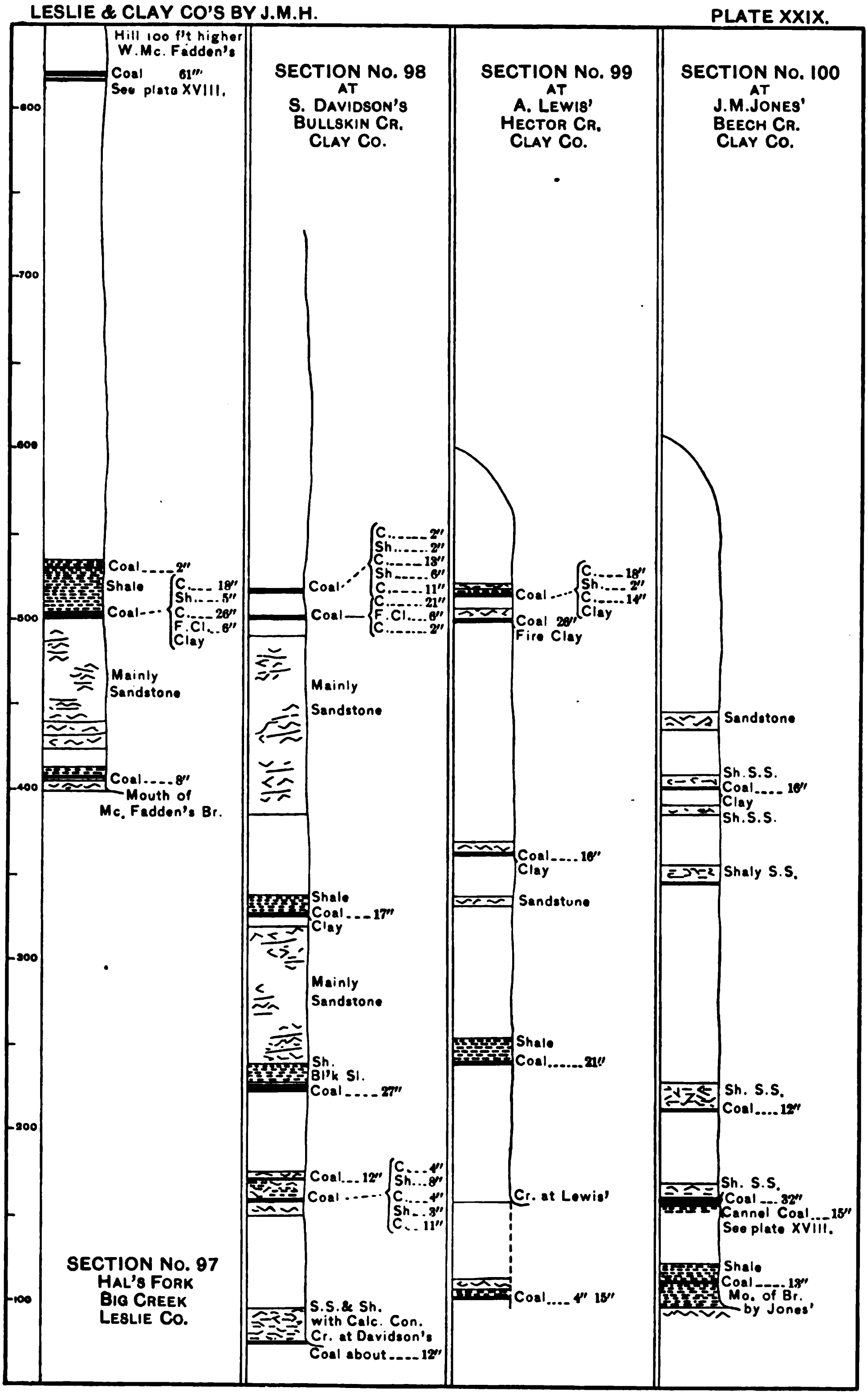


Folger Eng.Cin.

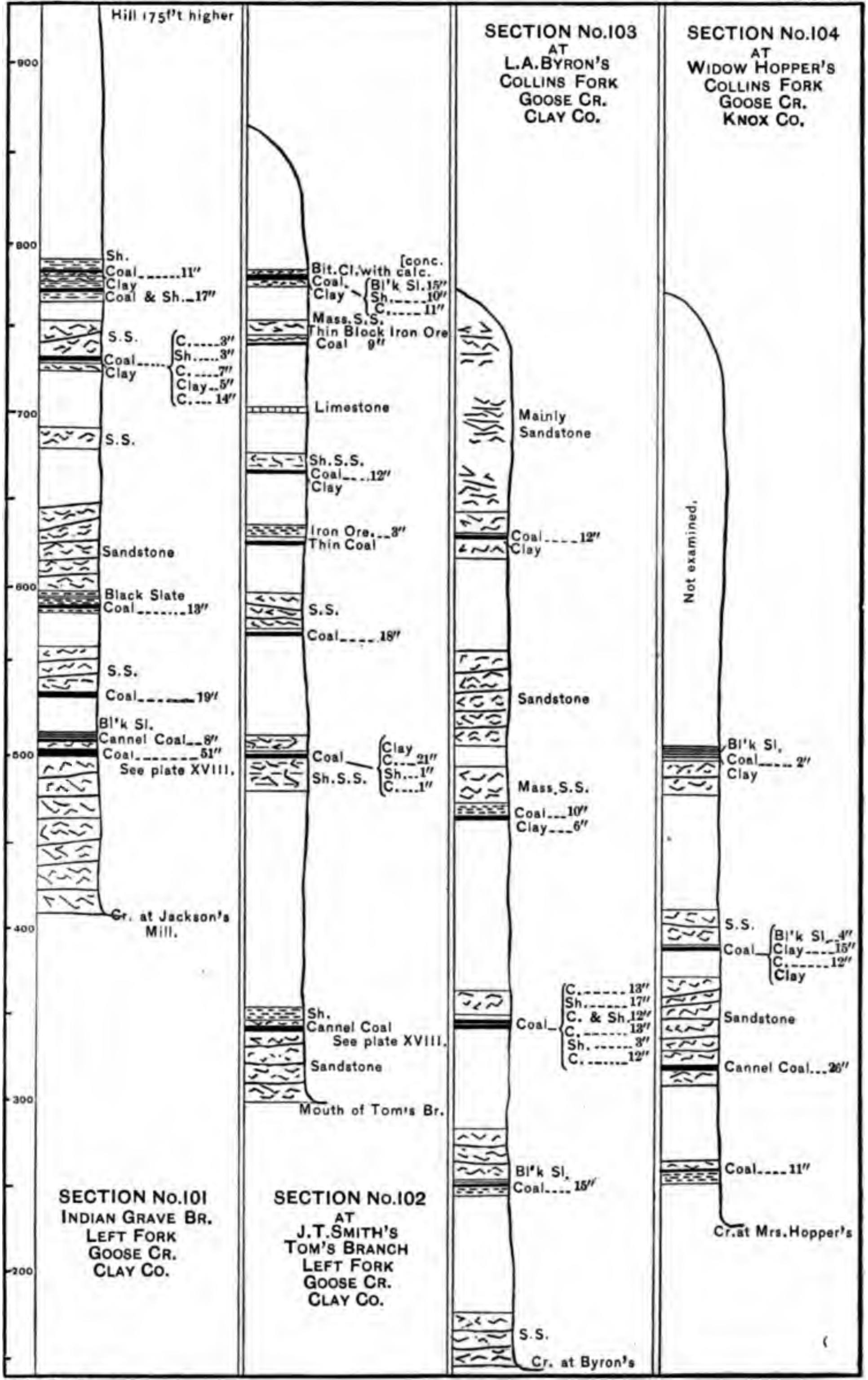
LESLIE & CLAY CO'S BY J.M.H. PLATE XXVIII.



L.B. Folger Eng. Co.



Folger Eng.Cin.


SECTION No.101
INDIAN GRAVE BR.
LEFT FORK
GOOSE CR.
CLAY CO.

SECTION No.102
AT
J.T.SMITH'S
TOM'S BRANCH
LEFT FORK
GOOSE CR.
CLAY CO.

SECTION No.103
AT
L.A.BYRON'S
COLLINS FORK
GOOSE CR.
CLAY CO.

SECTION No.104
AT
WIDOW HOPPER'S
COLLINS FORK
GOOSE CR.
KNOX CO.

k is under no circumst
en from the Bui

[illegible]